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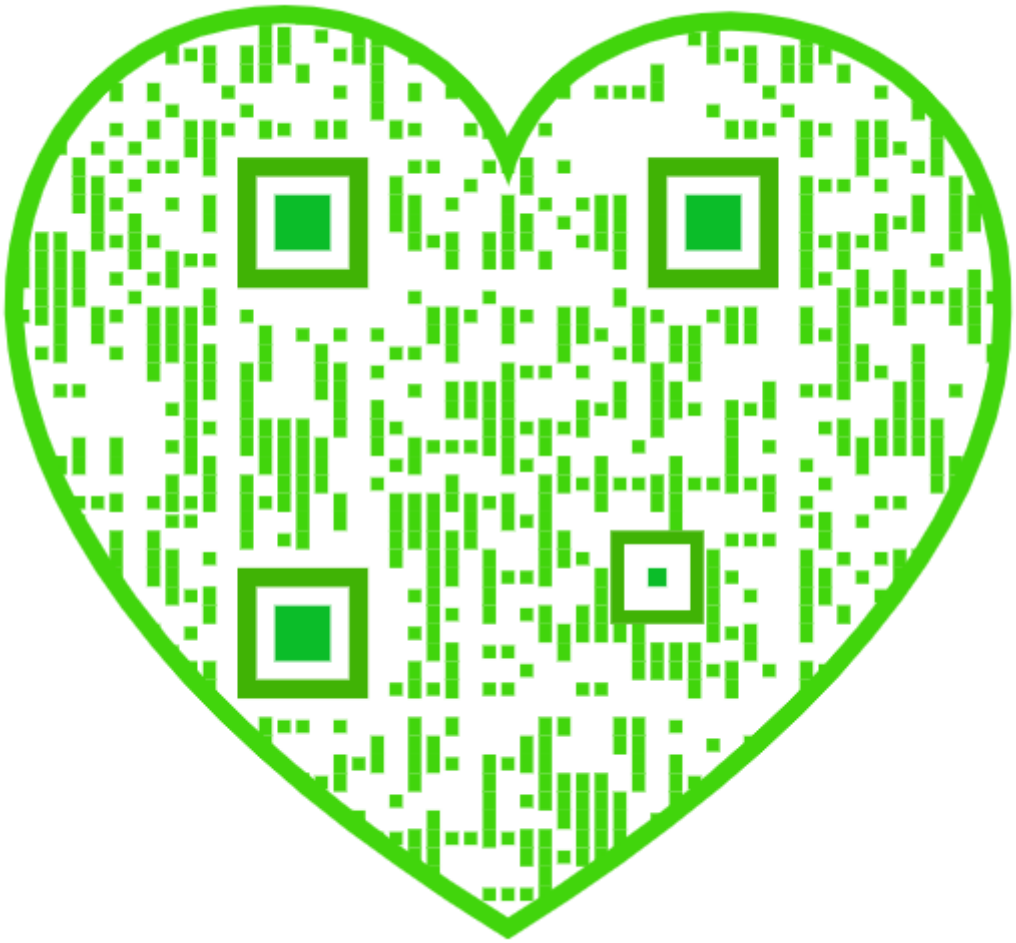

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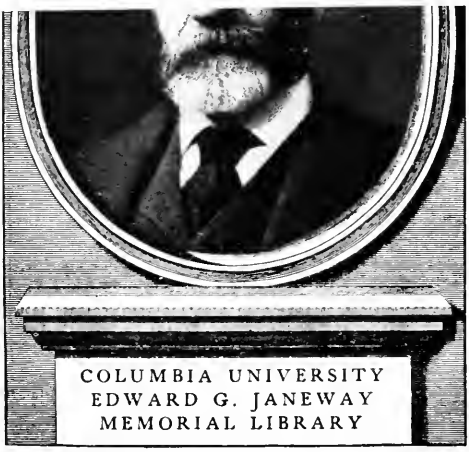
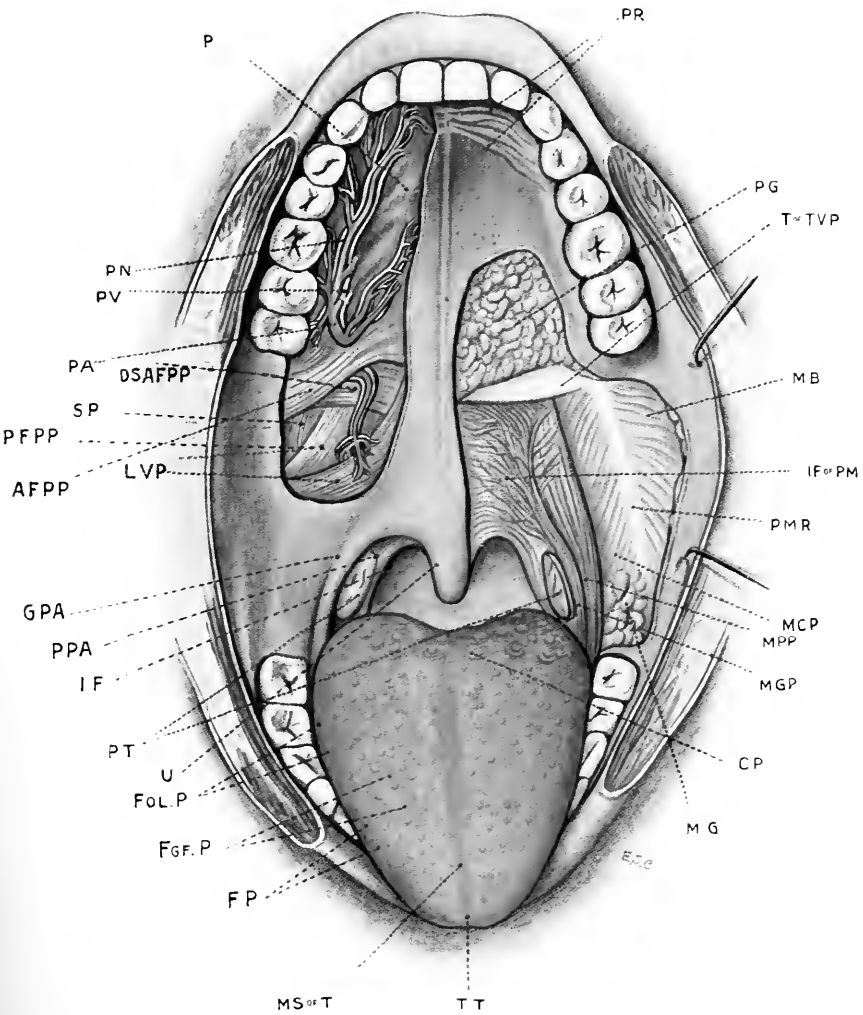


DESCRIPTION OF PLATE I

P. N. Anterior Palatine Nerve.
P. A. Greater Palatine Artery.
P. V. Palatine Vein.
P. Periosteum.
P. R. Palatine Rugæ.
P. G. Palatine Glands.
T. of T. V. P. Tendon of Tensor Veli Palatini.
M. B. M. Buccinnator.
I. F. of P. M. Interlacing Fibers of the Palatine Muscles.
P. M. R. Pterygomandibular Raphé.
M. C. P. M. Cephalopharyngeus.
M. P. P. M. Pharyngopalatinus.
M. G. P. M. Glossopalatinus.
P. T. Palatine Tonsils.
M. G. Molar Glands.
D. S. A. F. P. P. Deep Surface of the Anterior Fasciculus of the Pharyngopalatinus.
L. V. P. Levator Veli Palatini.
P. F. P. P. Posterior Fasciculus of the Pharyngopalatinus.
S. P. Salpingopharyngeus.
A. F. P. P. Anterior Fasciculus of the Pharyngopalatinus.
M. S. of T. Median Sulcus of the Tongue.
C. P. Circumvallate Papillæ.
Fgf. P. Fungiform Papillæ.
Fol. P. Foliate Papillæ.
F. P. Filiform Papillæ.
T. T. Tip of Tongue.
U. Uvula.
I. F. Isthmus of Fauces.
P. P. A. Pharyngopalatine Arch (Posterior Pillar of the Fauces).
G. P. A. Glossopalatine Arch (Anterior Pillar of the Fauces).

PLATE I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THE SURGERY

OF

ORAL DISEASES AND MALFORMATIONS

THEIR DIAGNOSIS AND TREATMENT

BY

GEORGE VAN INGEN BROWN, D.D.S., M.D., C.M., F.A.C.S.

MAJOR, MEDICAL OFFICERS' RESERVE CORPS, U. S. ARMY.
ORAL SURGEON TO ST. MARY'S HOSPITAL AND TO THE CHILDREN'S FREE HOSPITAL AND COLUMBIA HOSPITAL, MILWAUKEE; FELLOW OF THE AMERICAN MEDICAL ASSOCIATION; MEMBER OF THE NATIONAL DENTAL ASSOCIATION; CHAIRMAN OF THE SECTION ON ORAL SURGERY OF THE FOURTH INTERNATIONAL DENTAL CONGRESS, ETC.

THIRD EDITION

WITH 570 ENGRAVINGS AND 20 PLATES, AND A SELECTED LIST OF EXAMINATION QUESTIONS

LEA & FEBIGER
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TO

EMILY LYNCH BROWN

MY MOTHER

AND

ELIZABETH KATHLEEN SELBY BROWN

MY WIFE

PREFACE TO THE THIRD EDITION.

The most important changes in this, the third edition, of this work are to be found in the chapter relating to war surgery.

Hitherto undreamed-of mutilations of jaws and faces by high explosives in this war have necessitated many radical changes in the methods of immediate treatment of these war injuries.

In natural sequence has also come the elaboration and the execution of many wonderful surgical plastic operations and prosthetic devices for the reconstruction and rehabilitation of these honorably deformed and battle-scarred individuals.

Oral and plastic surgery as recognized by the Surgeon-General of the United States Army promises great achievement for the alleviation of these distressing conditions, and it is evident that the association of surgeons and dentists thus created for the prosecution of this work must require an extensive knowledge on the part of each of the possibilities for good accomplishment of the methods of the other in order that through complete coöperation the best results may be secured.

To meet this situation the author has endeavored to gather together representative ideas and methods as published from the work of the hospitals of practically all the principal nations now doing battle.

Large numbers of illustrations have been added to show desirable selections from an almost unlimited variety of splints that have been constructed along the lines of well-known fixation devices for securing fractured jaws, such as were illustrated and described in the previous editions, but in many cases so improved as to be capable of much wider usefulness than the earlier models.

With each succeeding edition the author feels more deeply a sense of appreciation of the value of the assistance rendered by those whose names have been mentioned in the prefaces for the first and second editions, all of whom he again thanks most sincerely.

At this time acknowledgment is also due to Joseph C. Beck, M.D., F.A.C.S., of Chicago, Professor of Otolaryngology, University of

Illinois, for the illustrations of his demonstrations on the cadaver that were given for the army schools of oral and plastic surgery at St. Louis and Chicago, and to Major Robert H. Ivy for courteous assistance.

A final tribute is due to all the men of genius in the belligerent countries whose faithful devotion has served to make oral surgery and prosthesis useful beyond belief. To each and every one of these workers, no matter where his abilities may have been exercised in behalf of wounded men, the obligation for records of the advancement of this science is sincerely acknowledged, with regret that it is not possible to mention by name each of the illustrious contributors.

G. V. I. B.

Milwaukee, 1918.

PREFACE TO THE SECOND EDITION.

In this the second edition of this work the author has found it necessary to make many revisions and additions in order to keep pace with the great strides forward that have been made in the surgery of oral diseases and deformities since the first edition was published.

This was found to be particularly true with regard to conductive anesthesia, focal infection of oral origin and maxillary expansion for the relief of nasal, nervous, mental, bronchial and other disorders.

The etiology and treatment of infectious diseases and neoplasms; methods for the deep injection of the trigeminal nerve at the foramen ovale, the foramen rotundum, and the Gasserian ganglion also required more complete elaboration in view of recent advancements.

The casualties of the world war made necessary an extension of the description of the methods of operative treatment of fractures, resections of the jaws and other mandibular affections, as well as for the treatment of wounds under war conditions.

The chapters on Harelip and Cleft Palate reflect the improvements that are the natural result of the growth of the author's widening experience in this special operative field.

For teachers and students the list of examination questions will be found to be an inestimable advantage, inasmuch as the chapters and headings in the text correspond to the grouping of the questions. These may be followed in outlining lectures and also for examination purposes, with much convenience both to lecturers and students.

To all who aided in the production of the first edition and all those whose researches and writings have been utilized in quotations or otherwise the author again extends sincere expressions of appreciation.

With particular reference to this second edition the author is indebted to Dr. O. H. Foerster, of Milwaukee, for revision of the chapters on Diseases of the Mucous Membrane of the Mouth and Syphilis; to Dr. Francis J. Wilson, of Paris, formerly of the American Ambulance Hospital (B. at Juilly), France; Dr. George B. Hayes and Dr. William S. Davenport, of the American Ambulance Hospital, Neuilly (Paris),

France; Dr. Edward C. Kirk, editor of the *Dental Cosmos;* Dr. Joseph Rilus Eastman, Indianapolis, Ind., formerly chief surgeon, Reserve Hospital No. 8, Vienna, Austria; Dr. George E. Meyer, of Chicago, Ill., Major, R. A. M. C., formerly Oral Surgeon of the Twenty-third General Hospital, British Expeditionary Force, France, and Captain S. D. Boak, D.S.C., Columbus Barracks, Columbus, Ohio, for original contributions and assistance in the preparation of the chapter on the Treatment of Wounds under War Conditions; to Dr. Sheppard W. Foster, of Atlanta, Ga., for much clinical illustrative material; to Dr. Albert J. Ochsner, of Chicago, and Drs. Edward S. Judd and Gordon New, of the Mayo Clinic, Rochester, Minn.; Dr. Fred H. Albee, of New York, Dr. Vida A. Latham and Dr. Eugene S. Talbot, of Chicago, for valuable illustrations and descriptions of interesting cases.

A special word of thanks is also due to Dr. George A. Harlow, of Milwaukee, whose advice and efficient coöperation in conducting army examinations went far toward making possible the completion of this work under present conditions, and to Dr. Selby Van Ingen Brown for additional assistance of this character.

G. V. I. B.

Milwaukee, 1917.

PREFACE TO THE FIRST EDITION.

In the preparation of this work the author has endeavored to meet certain demands the urgency of which has been borne in upon his mind after more than thirty years' experience in the treatment of oral diseases and malformations. During the last ten years of this period his practice has been limited to these affections. Through frequent consultations and coöperation in the treatment of patients who have been referred, he has been closely in touch with dentists, general surgeons, internists and those whose practices have been limited to rhinology, ophthalmology, otology, pediatry, dermatology and other divisions of medical practice. This volume is therefore designed to be a book of reference touching all these medical interests in their oral relation.

As a teacher of oral surgery he has also become convinced that for many reasons there is great need of a text-book adapted to both didactic and recitational instruction on this subject, sufficiently concise and well systematized to permit of accommodation of the course to the stringent time limitations of a college curriculum and yet impressing the salient points to the best possible advantage, and so arranged as to facilitate the work of students in preparing themselves for examination. While meeting these requirements it is believed that this work is sufficiently comprehensive and practical to make it a useful guide in trying clinical situations after graduation.

The chapters on Harelip and Cleft Palate represent the chief part of the author's life work. His conception of the presentation of the subjects is based upon extended observation of the confusing conditions which surround those who are called upon to treat such cases in the course of general practice. There is much diversity of opinion among writers as to the best methods of procedure, and the ill results of a wrong step in treatment are great and long continued. The clinical aspect has been kept constantly in view in order to provide a dependable source of information. Many original drawings have been carefully prepared to show each operative step in the correction

of these deformities. Much space has been given to the explanation of operative methods and the underlying factors which influence results. The pictures of large numbers of patients are shown in order to emphasize the thoroughly practical clinical value of operations and corrective measures that are recommended. These are in the form of engravings made from photographs. They are therefore true examples of the results of treatment which is in harmony with the developmental principles that govern facial symmetry, speech function and nasal form. Upon these influences also depend freedom from nasal disease and other more widely distributed affections, both general and local. All illustrations except those credited to other writers are representations of the author's cases.

It is well known that grave consequences might often be avoided by the early detection and correction of quite simple mouth diseases. Too commonly these cases have been allowed to advance to a state of hopelessness or radical surgical operations have been inadvisably performed with unnecessary personal disfigurement or danger as the result. Many extrabuccal affections might also be checked in their incipiency if dentists who have opportunity to observe them during early stages fully recognized their significance.

The discussion of a field of practice with hitherto ill-defined limitations, situated like the hub of a great physiological and pathological wheel, around which center and from which radiate almost limitless possibilities for the reception and extension of disease, has required much thought in the determination of its boundaries. In this effort the difficulty of conveying a true idea of the etiological and pathological importance of the oral region in relation to other parts and to the organism as a whole without going too far afield in the discussion has been realized.

Great labor has been expended in an effort to present the subject with sufficient broadness to cover all affections directly and indirectly related, and yet to confine descriptive matter to facts that are essential to the fulfilment of the purpose of the work.

Widening of the nares by separation of the maxillæ for the correction of nasal defects and the control of pathological influences that may affect the nose and associated parts through the mouth is fully illustrated and described, because such work is properly within the scope of the functions of the oral surgeon.

The operative treatment of diseases of the nose and throat has been omitted because this lies outside of the province of oral surgery.

Although partial or complete stenosis of the nares, deflected nasal septa, diseases of the nasal accessory sinuses, adenoids and enlarged tonsils and pathological results attendant upon these conditions are commonly associated with diseases and malformations of the mouth, their improvement often being attendant upon the correction of oral defects, it is nevertheless true that rhinologists are better fitted for the local operations they require, and whenever possible should be the only ones to attempt them.

In like manner it will be obvious to all thoughtful readers that operations such as the removal of the Gasserian ganglion can only be safely performed by surgeons of acknowledged skill and long experience in brain surgery, and extensive resections of the jaws, grave operations upon the tongue, dissections of cervical glands, as well as many less extensive operations upon the eyes, ears, nose and other parts that may be and often are associated with the mouth in disease, can best be performed by those whose practice has especially fitted them for the diagnosis and surgical operative treatment of pathological conditions within the region of their greatest experience. Description of the technic of all such operations, with sufficient detail to prepare those unfamiliar with them for their proper performance, would be impossible in a work of this character, and the attempt would be unwarranted. On the other hand, because the symptoms of diseases requiring such operative treatment are so frequently manifested in the mouth, familiarity with their nature and the indications by which they may be recognized is vitally important for all who treat oral diseases. Again, in order to secure the best results it is necessary not only that such cases be carefully diagnosticated, but also that the one who refers them should have at least an intelligent idea of the most appropriate methods of treatment. It has therefore been the author's purpose to include all important pathological conditions that affect or are influenced by the buccal cavity and its immediately surrounding parts; to deal thoroughly with the etiology and symptoms of these affections and to describe the necessary operative procedures clearly and concisely with sufficient detail to give a thorough understanding of the most approved methods of treatment, the risk involved and the probable results.

Mindful of the great advancement of dentistry, particularly in oral hygiene and prophylaxis, oral bacteriology and pathology, the treatment of buccal diseases and the study of their underlying developmental principles; cognizant also of the great opportunity for the

application of knowledge of general diagnosis, pathology and surgical treatment in this field, such as might only be expected of those whose experience has been upon the broad lines of more general medical practice; with keen realization of the imperative necessity for exact and specific methods of diagnosis when other parts are involved in oral disease, the author has long hoped to provide a work for consultation which might lead to a more direct clinical application of all these opportunities.

The author is greatly indebted for valuable advice, scientific information, personal letters and other assistance to Dr. Edward C. Kirk, of Philadelphia; Dr. Eugene S. Talbot, of Chicago; Dr. O. H. Foerster, Dr. Nelson M. Black and Henry D. Goodwin, of Milwaukee; Dr. Lee W. Dean, of Iowa City; Dr. Vida A. Latham, of Chicago; Dr. M. H. Cryer, of Philadelphia; Dr. Albert J. Ochsner, of Chicago; Dr. Charles H. Frazier, of Philadelphia; Dr. George W. Crile, of Cleveland; Parke, Davis & Co. and Dr. N. S. Ferry, of Detroit; Dr. Shepard W. Foster, of Atlanta, Ga.; *The Journal of the American Medical Association;* The S. S. White Dental Manufacturing Company and many other friends and confrères in this and other countries for helpful coöperation and contributions to literature which have been freely quoted.

G. V. I. B.

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SURGERY OF ORAL DISEASES AND MALFORMATIONS.

CHAPTER I.

ANESTHESIA—HEMORRHAGE—SHOCK.

ANESTHESIA.

The administration of anesthetics for oral operations presents all the dangers incident to general anesthesia for operations in other regions, as well as additional factors which render safe continuous insensibility to pain more than ordinarily difficult to secure. As these are of primal clinical importance in oral surgical operations, it seems best to limit the consideration of the general subject of anesthesia to its essentially practical aspects, without attempting to include details which may be found in monographs and text-books such as De Ford's work on *Anesthetics*.[1]

The term *anesthesia* literally denotes loss of sensation of touch, but its usual application is accepted as meaning the state of profound unconsciousness induced by anesthetics.

Insensibility to pain may be produced with or without simultaneous loss of common sensation, but as usually applied in surgery *analgesia* means loss of ability to feel pain without complete unconsciousness. Anesthesia may be *local* or *general*. The *principal anesthetic agents* are:

Solutions injected into the tissues to produce local anesthesia.
Freezing.
Nitrous oxide gas.
Nitrous oxide gas and oxygen.
Nitrous oxide gas, oxygen, ether sequence.
Somnoform.
Ethyl chloride.
Chloroform.
A. C. E. (alcohol, chloroform, and ether) mixture.
Ether.
Scopolamin, morphin, ether.
Rectal anesthesia.
Spinal anesthesia.
Intravenous anesthesia by ether and chloroform.

[1] Lectures on Anesthetics in Dentistry.

Local Anesthetics.—Local anesthetics, consisting of various combinations of cocain, eucain, and other drugs, have been quite generally used in minor operations for many years, particularly by dentists in the extraction of teeth. Sloughing and necrosis, which sometimes involve the bone structures extensively, have been frequent results of this practice. In at least one case within the author's knowledge paralysis and serious cerebral symptoms followed the use of cocain and adrenalin injected with a high-pressure syringe for the extraction of an impacted third molar. Failure to observe proper surgical cleanliness, which may cause bacterial or other matter to be forced from the oral cavity into the circulation, and drugs which may act as emboli, have caused much of this trouble. With careful technic and discriminate use of drugs, local anesthesia has an important place in oral as well as other operations. It is valuable not only when entirely depended upon to abolish painful sensation, but also as an adjunct to general anesthesia for nerve blocking to prevent shock and to reduce the amount of the general anesthetic required.

Cocain.—Cocain, an alkaloid extracted from coca leaves, is widely and successfully used by application to mucous membrane surfaces, particularly for operations on the eyes and nose. It also forms the basis of many of the extensively advertised proprietary local anesthetics.

The difficulty of obtaining a supply of novocain under war conditions has recently caused more or less experimentation in the clinical application of cocain by injection, and better results are reported with the more improved modern technic than was formerly obtained by old methods. Various combinations of cocain with adrenalin have given good results without appreciable toxic effect.

Nevertheless its high degree of toxicity cannot be denied. Almost unlimited clincial evidence points to the danger of individual susceptibility which sometimes renders almost infinitesimal doses very dangerous. Even the combination of cocain with adrenalin or suprarenin does not always give entire freedom from toxic effects. The possibility of the beginning of the much-to-be-dreaded cocain habit is also a serious objection to its use.

Eucain.—Eucain is much safer than cocain, and possesses nearly as well-marked anesthetic properties.

Stovain and Novocain (0.5 per cent. solution).—Mainoli[1] strongly urges a wider use of this mode of anesthesia in major as well as minor operations. He has had no local difficulties, *e. g.*, skin sloughing, but he seldom uses a stronger solution than 1 per cent. given in a 10 c.c. syringe. It is well to remember, if the syringe is sterilized in an alkaline solution, that stovain becomes chemically altered and is physiologically inert. Lately he has discarded adrenalin, as he claims it gives no real advan-

[1] British Med. Jour., November 19, 1910, quoted from Riforma Medica.

tage. Novocain, he holds, lessens the smarting which stovain sometimes causes.

Apothesin.—Apothesin is a synthetic anesthetic now being brought forward as a substitute for novocain. It is claimed to be fully as potent as, and also less toxic than the various similar substances, such as stovain, cocain, novocain, and eucain. Allen[1] states it is readily soluble in alcohol and very soluble in water. He reports in detail upon a large number of injections made upon himself for experimental purposes and also has had successful clinical experience. It is supplied in $1\frac{1}{4}$-grain tablets, which dissolved in 60 minims of water makes a 1 per cent. solution. It is claimed to be suitable for use in any surgical procedure which requires the use of a local anesthetic. The solution generally employed is 5 per cent. to 3 per cent. Reports from 900 to 1000 operations by many operators, and for a large variety of operations, seem to indicate its safety and efficiency, both of which time will be required to fully determine.

Quinine-urea Hydrochloride.—The advantages claimed for quinine-urea hydrochloride as a local anesthetic are: (1) Any operation ordinarily done under cocain can be done with quinine-urea. (2) The duration of anesthesia with 0.5 to 1 per cent. solutions is longer than when cocain is used. (3) Solutions of this strength (1 per cent.) cause some induration. (4) Union may be a little delayed by a fibrinous exudate when the stronger solutions (1 per cent. or over) are used. (5) In operations about the anus and in tonsillectomies it is the anesthetic of choice, as it has a hemostatic effect and the pain of dressings is avoided.

Its advantages over cocain are: (1) Its absolute safety. (2) The duration of anesthesia. (3) Its hemostatic effect.

H. F. Graham tried this combination in 17 cases. A 1 per cent. solution was generally used (made from the 2-grain tablets of Parke, Davis & Co.), and the solution boiled before use. As a result of his experience, he believes it is a perfectly safe local anesthetic, causing only slight local irritation. It does not cause tissue destruction, and if it interferes with healing at all, does so only to a slight degree.

Partial Scopolamin Anesthesia for Aged.—A method of anesthesia for the aged, advocated by J. H. Gleason,[2] is as follows: Some six years ago he conceived the idea of combining partial scopolamin anesthesia with local anesthesia, using 0.1 per cent. of cocain. The scopolamin was added to control the nervousness and excitement usually complicating operations under local measures. This technic proved so successful that about a year later, opportunity having presented itself, he began to use partial scopolamin anesthesia combined with local sterile water infiltration in the aged.

[1] New Orleans Med. and Surg. Jour., March, 1917.
[2] New York Med. Jour., June 30, 1910.

Infiltration Anesthesia.—Schleich's formula for infiltration anesthesia:

Cocain hydrochlorate	0.2
Morphin hydrochlorate	0.025
Sodium chloride	0.2
Water to make	100.0

Sterilize and then add two drops of 5 per cent. solution of carbolic acid.

Infiltration and Conductive Anesthesia (Nerve-blocking).—Novocain is a synthetic preparation entirely different in its chemical nature from cocain. Its record of thousands of injections in persons of all ages, under many different conditions, with almost no serious results at present entitles it to first rank among the agents for inducing both infiltration and conductive anesthesia.

According to Le Borcq, "If the toxicity of cocain be represented as 1, then

"The toxicity of alypin will represent 1.25.

"The toxicity of nirvanin will represent 0.814.

"The toxicity of stovain will represent 0.625.

"The toxicity of tropacocain will represent 0.500.

"The toxicity of novocain will represent 0.490.

"The toxicity of beta-eucain lactate will represent 0.414."

Braun recommends the use of solutions for this purpose varying from 0.25 per cent. to 2 per cent. novocain, but from 1 per cent. to 1.6 per cent. solution is recommended by Fischer, Seidel, Blum and Thoma, and approximately these percentages are generally used for dental and oral operations.

Fischer advocates a novocain solution of the following composition:

Novocain	1 or 1.5 or 2.0
Sodium chloride	0.5
Calcium chloride	0.04
Potassium chloride	0.02
Sterile aqua destillata	100.0
Synthetic suprarenin (1 to 100)	0.002

The equipment for this purpose consists of a syringe, as shown in Fig. 1 with both long and short needles, and trocar needles, as shown in Figs. 2 and 3; a glass jar for preserving the syringes in the sterile alcohol solution; a small porcelain dissolving cup, and a stock flask for the Ringer solution (Fig. 4); platinum and iridium needles are desirable because of the danger of breaking which steel points offer. Distilled water is preferable to undistilled boiled water because of its greater purity. A convenient apparatus for the distillation of water makes a desirable addition to this armamentarium. The best way to make a syringe sterile is to boil it.

Technic of Infiltration Anesthesia.—The technic of Thoma, of Harvard, includes scrupulous cleansing preparation of the mucous mem-

brane surface, touching the point of entrance with the solution of iodin and aconite. Then with the syringe held like a writing pen the needle

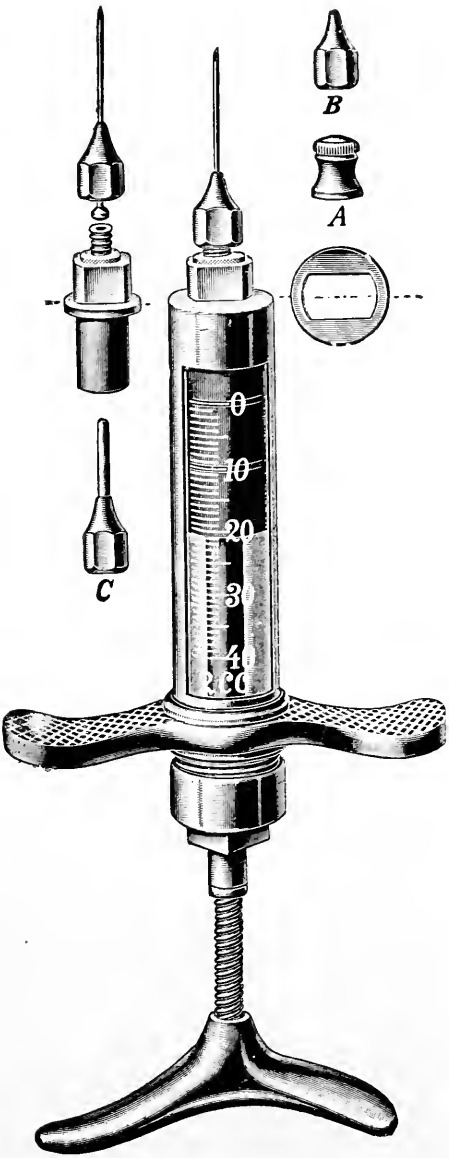


Fig. 1.—Fischer injection syringe.

is pushed—opening directed toward the bone—down to the periosteum, and thence upward, just a little higher than the apex of the root. The

injection must be made slowly and evenly, and, if correct, very little force is needed. In this manner, deposit of 1 to 1.5 c.c. of a 1.6 per cent. solution just over the apex of the root, between mucous membrane and bone. The tissue should not turn white and the velum is hardly noticed, because the deposit of the solution is higher than the mucous fold of the cheek. At the palatal side, insert the needle nearer the gingival margin, push it down parallel with the root and inject 0.25 c.c.

FIG. 2.—Syringe for trocar.

of the solution. The anesthesia takes place in from five to eight minutes. Massage of the part will help quicken the process. The anesthesia lasts for one hour, and any dental or surgical operation can be performed on this tooth.

Braun states that descriptions of the method of anesthetizing the inferior alveolar and lingual nerves at the lingula were given by Halsted and Raymond (1885). Efforts were then made by dentists to block

the inferior alveolar nerve at the lingula (Thiesing, Krichelsdorf, Dill and Huebner) by means of cocain-suprarenin solution, and this method has now become one of the common procedures of the dentist.

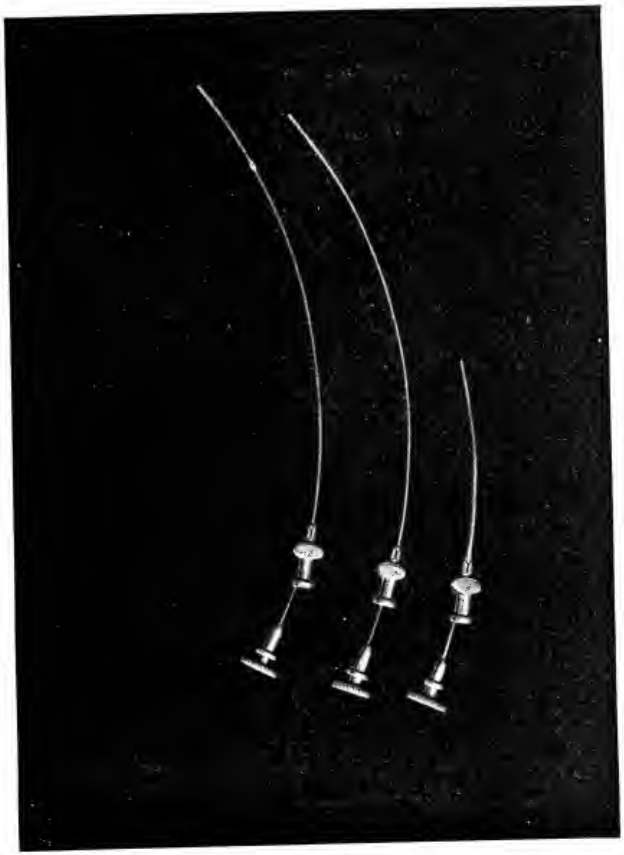


FIG. 3.—Trocar needles with telescoping attachments. (Fischer.)

The technic of the operation, according to Braun's method is as follows:

In order to anesthetize both nerve trunks, proceed in this manner: With the patient in a sitting posture and the mouth wide open, the operator introduces the index finger of the left hand and locates the anterior border of the coronoid process, and the "trigonum retromolare" (retromolar triangle). The needle is directed from the opposite canine tooth toward the retromolar triangle and held parallel to the biting surface of the lower teeth. The needle is inserted at the above-mentioned point 1 cm. above and laterally to the biting

surface of the last molar tooth into the "trigonum retromolare." Immediately under the thin mucous membrane the bone should be felt. If this is not the case, the point of the needle is too far mesially, a mistake frequently made by beginners. The needle is now directed gradually toward the median line until the internal oblique line is felt.

The needle finally passes along the inner surface of the lower jaw into the deeper parts. It must now be further inserted to a depth of 2

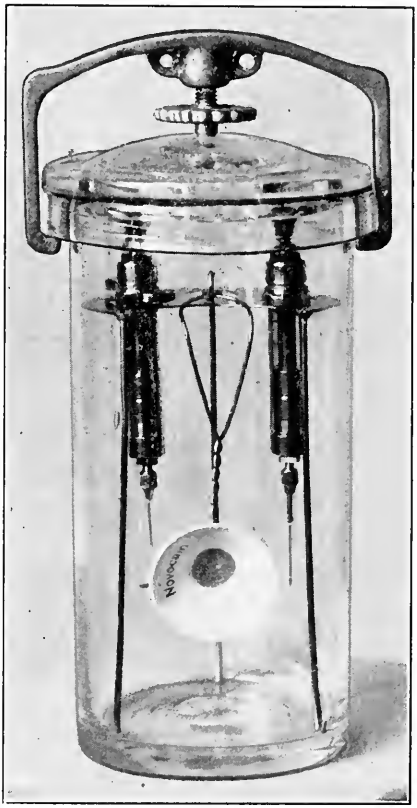


FIG. 4.—Hermetically sealed glass jar for preserving syringes, dissolving cup, and pliers in alcohol-glycerin solution. (Fischer.)

to 2.5 cm., keeping it always in contact with the bone. On the whole path described by the needle point, beginning immediately under the mucous membrane, where the lingual nerve lies, 5 c.c. of a 1 to 2 per cent. novocain-suprarenin solution should be injected. The methods of injection are illustrated in Figs. 5 to 10.

FISCHER'S TABLES FOR INJECTING LOCAL ANESTHESIA.

TECHNIC OF INJECTION EMPLOYED.

Teeth	(*a*) Simple cases.	(*b*) In cases complicated by periostitis, parulis, abscesses, etc.
I. UPPER.		
1. Central incisors.	Needle inserted at middle of root of lateral, and directed to root apex of central.	Needle inserted at middle of roots of canine of same, and central of opposite side, whose root apices are infiltrated with solution palatally, injections at lateral of same, and central of opposite side. Or conductive anesthesia at infra-orbital foramen, and mucous anesthesia at central of opposite side, palatally.
2. Lateral incisors.	Needle inserted at middle of root of canine and directed to root apex of lateral. Palatally, injection at lateral.	Needle inserted back of root apex of canine, where solution is deposited; same procedure at root apex of central. Palatally, injection at lateral, or at central and canine.
3. Canines.	Needle inserted at root apex of canine, where solution is deposited. Palatally, injection at canine.	Conductive anesthesia at infra-orbital foramen. Palatally, injection at canine, or first bicuspid and lateral.
4. First biscuspids.	Needle inserted at middle of root of canine, and directed to root apex of first bicuspid. Or injection at maxillary tuberosity.	Injection at maxillary tuberosity.
5. Second bicuspids.	Needle inserted at middle of root of first bicuspid and directed to root of second bicuspid. Or injection at maxillary tuberosity.	Injection at maxillary tuberosity.
6. First molars. 7. Second molars. 8. Third molars.	Injection at maxillary tuberosity.	
II. LOWER.		
9. Central incisors.	Needle inserted at root of lateral and directed to root apex of central. Lingually, injection at central.	Needle inserted in reflection of mucous membrane below canine and directed to mental fossa, where solution is deposited.
10. Lateral incisors.	Needle inserted at middle of root of canine, and directed to lateral. Lingually injection at lateral.	Needle inserted in reflection of mucous membrane below canine, and directed to mental fossa, where solution is deposited.
11. Canines.	Needle inserted in reflection of mucous membrane below canine, and directed to mental fossa, where solution is deposited. Lingually injection at canine, first bicuspid, or mandibular anesthesia.	Needle inserted in reflection of mucous membrane below canine, and directed to mental fossa, where solution is deposited. Mandibular anesthesia.
12. First and second bicuspids and first and second molars.	Mandibular anesthesia.	

Stern recommends an injection of the sphenomaxillary, for which purpose he uses a modification of the Fischer syringe with bayonet

FIG. 5.—Illustration of the direction of the syringe in injection on the labial side for roots of the anterior teeth.

attachment and needle (see Figs. 11 and 12) and claims thereby a more complete anesthetization, which includes with greater certainty the pulps of the bicuspid teeth.

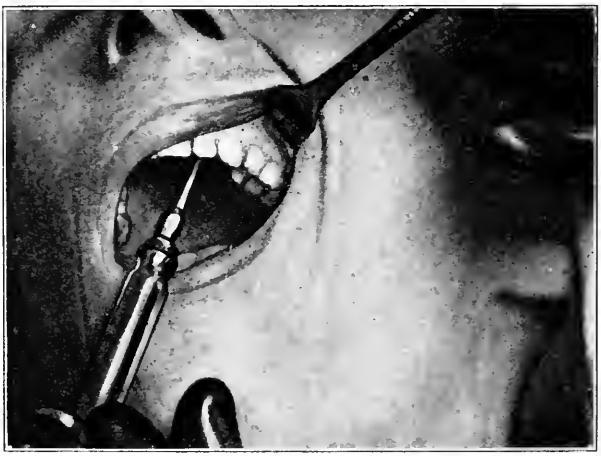


FIG. 6.—Illustration of the direction of the syringe for injection of the lingual aspects of the roots of the anterior teeth.

Danger.—The actual danger, with careful technic, is practically *nil*, but cases have been reported in which unduly prolonged, appar-

ently hypnotic slumber, evidences of slight toxic action, and distress due to injection of the agent into the muscles instead of close to the

FIG. 7.—Illustration showing the direction of the syringe for injection on the palatal side for bicuspid and molar roots.

bone, and occasionally local disturbances due to hemorrhages have been observed.

FIG. 8.—Injection at the infra-orbital foramen.

The forcing of infection from septic foci at the apices of, or otherwise in connection with the roots of the teeth is always a serious menace when such conditions exist. Stern[1] calls attention to this danger,

[1] Dental Cosmos, January, 1916.

and Fischer has also given the matter much consideration as shown by the foregoing partial representation of his chart (page 25), indicating the difference in the technic of injection employed in simple and diseased

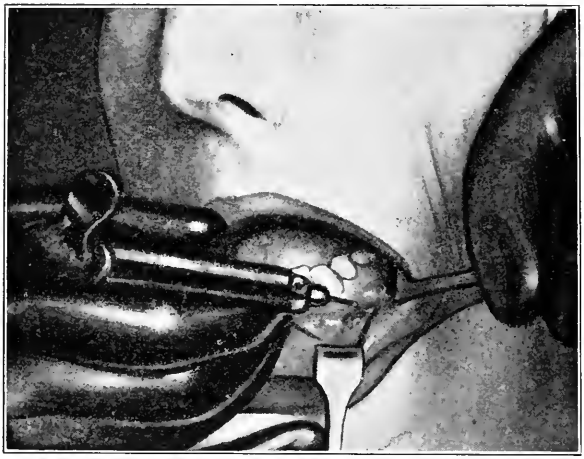


FIG. 9.—Injection at the mental foramen for anesthesia of the anterior teeth.

cases. Doubtless many results attributed to the anesthetic agent have really been due to injudicious extension through faulty technic.

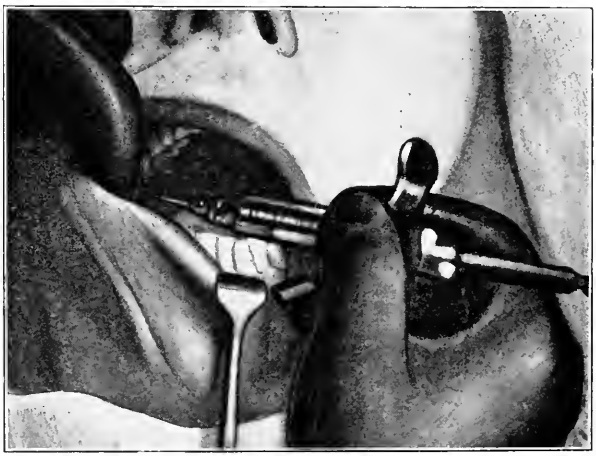


FIG. 10.—Direction of syringe for injection at the mandibular foramen.

General Anesthetics.—For general anesthesia the oral surgical operator is practically limited to nitrous oxide and oxygen, somnoform, ether, and the nitrous-oxide-oxygen-ether, or the scopolamin, or hyocin-

morphin-ether sequence, as *nitrous oxide* without oxygen is not capable of sufficiently extended use, and the safe employment of *ethyl chloride* is too limited.

Rectal anesthesia is objectionable because of the likelihood of irritation and intestinal disturbance following its long continuance.

Spinal anesthesia is not applicable.

Intravenous anesthesia by ether and chloroform has been recommended by L. Burkhardt,[1] who uses a 5 per cent. solution of ether in sterile salt solution. This method is too little known and presents too many dangerous possibilities to warrant immediate recognition.

FIG. 11.—Stern's modification of the Fischer syringe with bayonet attachment for sphenopalatine injection.

FIG. 12.—Illustration of Stern's method of sphenopalatine injection.

Chloroform.—Notwithstanding the fact that chloroform has long been held to be the most satisfactory anesthetic for mouth operations, the author, after having used it for a number of years, unhesitatingly states that, except in the extremely rare cases where other anesthetics are contra-indicated, it should never be used even with infants and children. By careful administration, satisfactory results may be obtained by the use of ether, with less immediate and postoperative danger than follows chloroform. One patient, a young woman, aged about twenty-two years, was lost five days after operation, after sufficient recovery to have enabled her to return home if desirable, as a result of acetonuria and fatty degeneration of the liver, evidenced

[1] München. med. Wchnschr., November 16, 1909.

by almost continuous vomiting, which ended in black vomit, delirium, coma, and death, and other similar cases have since been reported by Bevan, Guthrie, Favil, and others. These have convinced the author that there is no warrantable excuse for the continued general use of an agent attended by the immediate mortality due to chloroform, and the comparatively high though seldom recorded postoperative death-rate that is doubtless even greater than is commonly believed.

Some exception must be made when chloroform is used with an apparatus attached to an oxygen cylinder, so that pure oxygen may be forced in with the anesthetic. In this way, the quantity of chloroform required to produce insensibility to pain is greatly reduced and the direct effect of the oxygen undoubtedly combats the dangerous elements of the drug. Unless there are contra-indications of unusual character, the author, however, prefers the use of ether, as described on page 33.

Nitrous Oxide Gas and Oxygen.—Nitrous oxide gas undoubtedly is the safest of all general anesthetics. Although extensively used for a long time, it is only recently that a full appreciation of its usefulness has developed, because, notwithstanding its simplicity, this agent requires great skill in administration to obtain the best result. Its mortality record during the years of its general use is much better than that of any other general anesthetic, and some of the deaths attributed to nitrous oxide anesthesia are undoubtedly due to other causes. Any operator can administer gas to the point of complete insensibility with the usual appearance of temporary asphyxiation and in short minor operations by rapid work accomplish fairly good results. But its safe administration in combination with oxygen, continued for an hour or longer, with the patient in a state of complete muscular relaxation or of analgesia, more or less conscious of what is being done but without painful sensation, requires skill, which must be supplemented by natural talent and adaptability upon the part of the administrator, and even then this skill can only be acquired by long experience, in sufficient degree to insure successful accomplishment. Such a result, however, is well worth painstaking effort to secure, because freedom from nausea and other unpleasant symptoms at the time of operation, and quick recovery, are, in many cases and under a large variety of pathological conditions, of priceless value.

That the prolonged administrations of nitrous oxide gas is not unattended by danger is shown by the following table of deaths:[1]

Case 1.—Teter: "Shock and Primary Cardiac Failure," *Jour. Am. Med. Assn.*, August 7, 1909, p. 448.

Case 2.—Crile: "Myocarditis Six Hours after Operation," *Southern Med. Jour.*, January, 1910, p. 29.

Case 3.—Lydston: "Anesthetic," *Med. Record*, November 12, 1910, p. 866.

[1] Miller, Alfred H.: Dental Cosmos, June, 1915.

Case 4.—Allen: "Uremia," *Boston Med. and Surg. Jour.*, October 19, 1911, p. 589.

Case 5.—Allen: "No Details," *Jour. Am. Med. Assn.*, February 10, 1912, p. 396.

Case 6.—Allen: "No Details" (ibid.).

Case 7.—Gatch: "Hyperthyroidism," *Jour. Am. Med. Assn.*, November 11, 1911, p. 1593.

Case 8.—Gatch: "Pericardial Effusion" (ibid.).

Case 9.—Gatch: "Lymphatic Diathesis" (ibid.).

Case 10.—Olow: "Diseased Heart and Arteries," *Beiträge klin. Chir.*, December, 1911.

Case 11.—Boys: "Anesthetic," *Surg., Gynec. and Obst.*, April, 1912, p. 388.

Case 12.—Miller: "Suffocation from Inspired Vomitus," *Jour. Am. Med. Assn.*, November 23, 1912, p. 1847.

Case 13.—Flagg: "Anesthetic," *New York Jour. Med.*, November, 1912.

Case 14.—Teter: "Impure Gas," *Jour. Am. Med. Assn.*, November 23, 1912, p. 1849.

Case 15.—Teter: "Impure Gas" (ibid.).

Case 16.—Salzer: "Anesthetic," *Jour. Am. Med. Assn.*, November 23, 1912, p. 1872.

Case 17.—Collins: "Impure Gas," *Jour. Am. Med. Assn.*, November 23, 1912, p. 1862.

Case 18.—Buchanan: "Anesthetic," *Jour. Am. Med. Assn.*, November 23, 1912, p. 1860.

"A. H. Miller[1] has collected references to 18 deaths. Teter knows of 26 fatalities. Rovsing was able to get track of 13 deaths, several of which had been suppressed. Gwathmey knows of 20 to 40 unreported deaths."

Practically all anesthetists state most positively that death occurs only from asphyxia, and if the anesthetist watches the color and pushes the oxygen, death cannot occur. In none of the cases detailed was death the result in any way whatever of asphyxia, but in all occurred without warning.

In Columbus, O., there have been 12 or 13 deaths when given for 1200 to 1300 major operations.

Nitrous Oxide-oxygen-ether Sequence.—The administration of nitrous oxide gas, preliminary to ether anesthesia, is at present quite generally employed in hospitals throughout the United States. Many ingenious devices, such as the inhalers of Teter, of Cleveland; Dr. Willis M. Gatch, of Baltimore; A. E. Clark, of Chicago; the S. S. White Co., of Philadelphia, and others have been designed to regulate the respective quantities of nitrous oxide, oxygen, and air employed, and the addition

[1] Baldwin: Practical Medicine Series, ii, 25, and Medical Record, July 29, 1916.

of chloroform or ether in such manner as to produce safe and gradual transition to the agent (whether chloroform or ether) that is to be depended upon for continued general anesthesia during the operation. Thus one of the principal objections to the use of nitrous oxide as a first step to ether is avoided, viz., that during the preliminary stage, patients quite frequently recovered sufficiently to overcome the intended benefit of the quick induction through the nitrous oxide of the anesthetic state. The apparatus which also permits reinhalation it is claimed gives much benefit.

Somnoform.—Somnoform is safer than ethyl chloride or ethyl bromide, which with methyl chloride are its component parts. Of all the general anesthetics, it is undoubtedly the easiest to administer and most rapid in action. According to De Ford, "the time required being from fifteen to thirty seconds, with a period of available anesthesia from sixty to three hundred seconds." (The death-rate of ethyl chloride is estimated to be 1 in about 5000 administrations.) Its chief recommendation for safety, however, lies in this, that it has been generally and carelessly administered, yet with almost perfect success, in clinical exhibitions and otherwise, by absolutely untrained people, to individuals who have had no sort of preparation or preliminary physical examination. Had it not been a more than ordinarily safe agent, the death-rate would long ago have become a serious matter. For very brief operations its value is undoubted. The limited knowledge of its effect in continued use or repeated administration, however, seems to limit it to operations that can be quickly performed or to administration as a preliminary to ether anesthesia. For children under age when nitrous oxide can be readily and satisfactorily given, and when the terror incited by ether administration is a serious danger in unduly exciting brain cells which may involve the vital centers, its use is undoubtedly advisable. Except in these cases the combination of nitrous oxide and oxygen, which can, with reasonable safety, be continued for an almost indefinite period, seems to be much more satisfactory.

The Desirable Conditions for Anesthesia for Mouth Operations.—With the mouth wide open and the operative field occupied by the hands of the operator, comparatively little opportunity is given to prevent the inhalation of air. Thus it is advisable to give the agent in concentrated form through such airways as are available and with the apparatus out of the way of the operator. For this purpose a rubber tube or tubes may be passed through one or both of the nares back into the pharynx, or the agent may be given by the mouth through a tube, hollow mouth gag, or other similar device. In this way at least some anesthetic may be continuously administered while the operation is in progress. Blowing chloroform or even ether in this manner, as with the Yunker and similar apparatus, so that condensation may force the anesthetic into the pharynx and thus lead to its being swallowed or

inhaled in crude form, may greatly increase its irritating properties and even endanger the life of the patient. To avoid this, the author recommends the use of heated anesthetics, given by the Gwathmey (Figs. 13

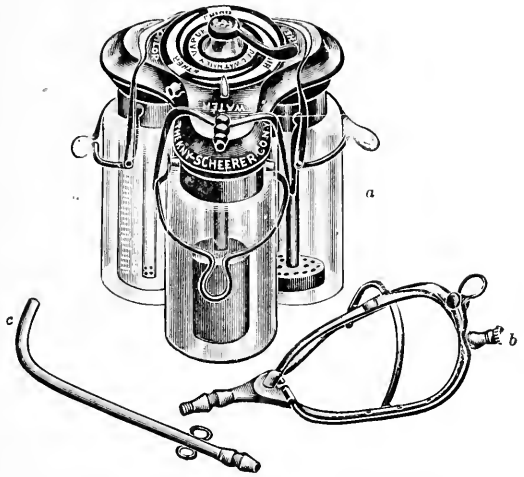


FIG. 13.—Gwathmey's vapor inhaler: *a*, *a*, bottles arranged for chloroform or ether, and hot-water bottle through which these agents are blown before passing into the administration tube. The proportions of air and anesthetic agent are regulated by turning the key at the top of the apparatus; *b*, hollow inhaler, with holes at the side to allow the vapor to pass under the mask covered with gauze; *c*, tube through which the vaporized anesthetic agent is blown into the mouth or nose. These are attached to the apparatus by rubber tubing and air is blown in by the use of rubber bulbs or foot bellows.

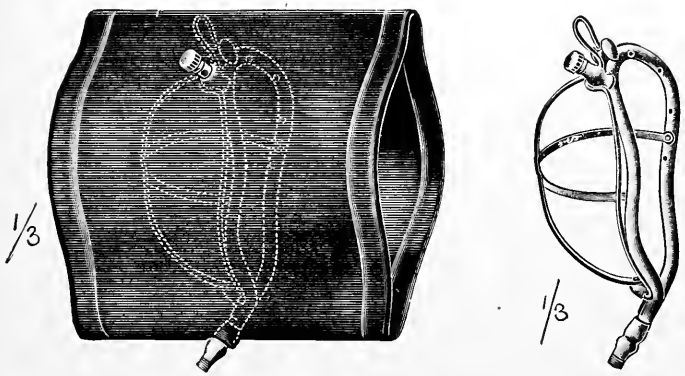


FIG. 14.—Rubber face mask placed over the inhaler to prevent the escape of the vapor during preliminary administration.

and 14) or some similar apparatus. By this method ether which has become vaporized by heat is blown through the tube in such manner that there will be a definite proportion of air with it. The increased efficiency of heated, vaporized ether makes a sufficiently steady anes-

thesia possible with a much smaller proportion of ether. Thus the danger is reduced and the likelihood of postoperative vomiting minimized. The latter almost invariably means infection in mouth operations and in cleft-palate cases, particularly after staphylorrhaphy, for the strain thus affecting the freshly united soft-palate tissue predisposes to failure, and must be avoided if possible. Too profound anesthesia, with all reflexes abolished, should be guarded against when profuse hemorrhage is likely, even though it may only be momentary, as blood is apt to be inspired in spite of every precaution, except when the pharynx is packed, and this is inadmissible for many operations. With care and skilful administration, the patient can be kept completely insensible to pain and sufficiently quiet for the steady progress of the operation, and yet not so deeply under the anesthetic as to abolish reflex action entirely, which, even though limited, is a very important safeguard. The ideal condition for anesthesia in this region is administration lasting the shortest possible time consistent with the rapid, thorough performance of the procedure. This implies skilful operation, with safe, continued, steadily maintained insensibility to pain, without loss of muscular and nervous activity sufficient to cause inspiration of blood, and prevent prompt recovery, with freedom from postoperative nausea and other ill effects.

A hypodermic injection of $\frac{1}{6}$ gr. of *morphin* and $\frac{1}{120}$ gr. of *atropin*, one-half hour before operation, reduces the time taken for induction of anesthesia, and therefore lessens the amount of the anesthetic required, thus diminishing the danger of the early stages of anesthesia and, in a considerable measure, also the tendency to shock. The atropin diminishes secretion and thus lends important aid to both anesthetic and operative conditions in the buccal and pharyngeal cavities. One-eighth to one-quarter grain of morphin injected after the operation serves to bring about a more quiet, restful recovery, with valuable abatement of the unpleasant symptoms following prolonged anesthesia.

The essence of orange administered with the ether at the beginning of the anesthesia is sometimes beneficial when the patients particularly dread the smell of ether.

Scopolamin-morphin or *hyoscin-morphin* administered hypodermically to bring about sleep, though insufficient for the performance of a major operation without the administration of an additional anesthetic, reduces the required amount of ether or other similar agent to the minimum. It has been frequently recommended by many writers, and is useful where more than ordinary apprehension of danger from ether exists. Its injudicious use has in some instances caused death through retardation of the action of the heart beyond the point of control; and until such time as experience shall have defined the limitations of this combination of drugs, prudence would indicate that its employment be regarded as merely substituting one form of danger for

another. H. C. Wood[1] reports 1988 cases and 23 deaths, 9 of which he believes should justifiably be attributed to the anesthetic, leaving the record of 1 death in 221 anesthesias. He states: "In view of the fact that this combination for the production of anesthesia is scientifically irrational, and has yielded a mortality of 4 per 1000, and in 69 per cent. of the cases the anesthesia has been unsatisfactory, . . . it must be either a very bold or very careless surgeon who will persist in its use."

Collins, who has had an experience of 1120 cases in which scopolamin-morphin was given preliminary to general anesthesia, gives the following description of its use:

"Tablets are obtained containing a combination of scopolamin $\frac{1}{100}$ gr., and morphin $\frac{1}{6}$ gr., and the solution is made just before it is administered hypodermically, which is done one and one-half hours before operation. Relatives or friends are not allowed to see the patient after the hypodermic has been given.

"The patient is not to be talked to and aroused. All necessary manipulations and handling of the patient are completed before the hypodermic is administered. The room is darkened and everything kept quiet, and he falls into a tranquil slumber. About twenty minutes before operation a layer of damp cotton is placed over the eyes and the patient is taken to the operating room and placed on the table. The preliminary cleansing of the skin is gently done while the general anesthetic is being administered. The preparation and anesthetization are usually completed about the same time, and the operation proceeds.

"The preliminary injection is given to all patients from eight years up. If an elderly patient is strong enough to undergo an operation, he is strong enough to have the beneficial effects of the combination, and it has not been withheld on account of age. Children are more apt to be nervous and apprehensive than adults; therefore the preliminary is given to all children of eight years and older.

"About thirty minutes after the hypodermic the patient becomes drowsy, and all apprehension and fear regarding the operation are gone. The transition from a partial sleep to complete anesthesia is not sudden, as from complete wakefulness, and is easily accomplished. After the operation he usually sleeps from three to five hours, and may partially awake and go to sleep again several times before becoming completely awake. The sleep saves him from the smarting pain of the recently incised tissues. There is much less postoperative vomiting, most patients having practically none. The secretion of mucus is markedly checked and in most cases is completely stopped. This prevents aspiration."[2]

[1] Jour. Am. Med. Assn., December, 1906.
[2] Ibid., March 26, 1910.

Endotracheal Anesthesia.—Endotracheal as administered with the Janeway apparatus gives perfect relaxation with less anesthesia than with inhalation, and its convenience for operations when surgeon and anesthetist occupy the same field is also emphasized. The method is apparently passing the trial stage, but until it is more generally adopted, there seems no good reason why it should supplant other well-established and satisfactory methods of anesthetic administration except in selected cases.[1]

Oil-Ether Colonic Anesthesia.—J. T. Gwathmey[2] claims the following advantages for this method of anesthesia.

(1) The apprehension and fear caused by a mask is avoided; (2) no expensive apparatus required; (3) after-effects reduced to a minimum; (4) a more complete relaxation than with any other method; (5) limits of safety are widely extended compared with other methods; and (6) a more even plane of anesthesia is automatically maintained than possible by any inhalation method—unless administered by a skilled anesthetist using a perfected apparatus.

The bowels should be cleared by castor oil and by irrigation. One hour before operation a mixture of 2 to 4 drams of ether in which is dissolved 5 to 10 grains of chloretone and 2 to 4 drams of olive oil, is injected into the rectum, or a suppository containing 5 to 10 grains of the chloretone is inserted. Half an hour before the operation a hypodermic injection is given of $\frac{1}{8}$ to $\frac{1}{4}$ grain of morphin sulphate and $\frac{1}{100}$ grain of atropin sulphate. About fifteen minutes before the operation the patient should be laid on the left side in a modified Sims position and a mixture of 25 parts olive oil and 75 parts ether passed into the rectum gradually, through the small tube to which the funnel and clamp have been fitted. One minute should be allowed for the introduction of each ounce of the mixture.

For children a mixture containing 50 to 65 per cent. of ether is sufficiently strong. One ounce of the mixture is required for each 20 pounds weight.

Good care should be taken to keep respiratory conditions free.

At the conclusion of the operation the clamp on the rectal tube is released, and the end lowered so the residual mixture is siphoned off. The Lockwood tube is inserted about 6 inches alongside the rectal tube. About a gallon of cold soapy water is then introduced through the funnel, being siphoned off by the Lockwood tube. Toward the end of this process the colon is massaged gently from right to left, thus expelling any liquid which may be left. The Lockwood tube is then removed; from 1 to 2 pints of cold water (tap water) is introduced through the rectal tube and the tube withdrawn.

[1] Vedin, A.: New York Med. Jour., July 29, 1916. Ochsner: Practical Medicine, Series 11, 1917.

[2] Lancet, December 20, 1913.

W. M. Johnson,[1] with an experience of 50 cases with no untoward effects, recommends the following prescription:

Paraldehyde	ʒij–iij
Olive oil	ʒij
Ether	ʒiij–v

He gives castor oil at 2 P.M. the day preceding, and the same night (after oil has acted) colon irrigation. In the morning one or two colon irrigations are given until the water returns clear. Two hours before operation 5 to 15 grains of chloretone per os.

A. D. Bevan[2] reports results of his study of anesthesia which would cover fully the entire surgical field to determine which would be the safest, most efficient, most satisfactory, to both patient and surgeon, simplest and least complicated. He desired also to find anesthetics which could be adopted and employed by medical men generally. From this stand-point the following have been analyzed:

Cloroform by open drop method; ether by open drop method; nitrous oxide gas; scopolamin and morphin; spinal anesthesia; blocking; infiltration; intravenous; general and local; intrarectal; intratracheal; intrapharyngeal; mixtures; sequences; anoci-association.

In each instance these agents and methods have been analyzed from the stand-point of:

Safety; comfort; efficiency; control; simplicity and general adaptability; after-effects on blood and tissues and viscera; complications, vomiting, etc.; paresis of bladder and bowels; effects on immunity to pus organisms, pneumococcus, etc.

The final results of his analysis are as follows:

1. Drop ether should be today chosen as the standard general anesthetic when a prolonged anesthesia is desired with relaxation and unconsciousness.

2. Gas should be chosen in short anesthesias in which unconsciousness is desired, and in special cases, *e. g.*, kidney insufficiency.

3. Intrapharyngeal ether should be chosen in mouth and jaw cases when it is desirable to remove the anesthetist and the apparatus out of the operative field.

4. Local infiltration anesthesia should be chosen when the surgeon has the full coöperation of the patient and when the field can be completely infiltrated and anesthetized by a safe amount of novocain and epinephrin.

These simple and safe methods can be made to cover all surgical cases. This places anesthesia on a very unpretentious, simple basis, but here as in most fields of surgery we finally learn that simplicity is near to truth.

[1] Practical Medicine, Series 11, 1917. Ochsner (editor): from Vermont Medica Monthly, August, 1916.

[2] Jour. Am. Med. Assn., October 23, 1915.

After performing operations upon dogs that had been given preliminary injections of chloretone at the Parke, Davis & Co. laboratories, and observing the growing tendency to recognize the value of morphin, scopolamin and morphin, and similar preparatory drugs, the author believes that future advances will undoubtedly be in the direction of greater use of these and similar preparations.

In this connection Dr. George V. Crile, of Cleveland, gives the following description of anoci-association, a word he has coined:

"The difference between anesthesia and anoci-association is that, although inhalation anesthesia confers the beneficent loss of consciousness and freedom from pain, it does not prevent the nerve impulses from reaching and influencing the brain, and hence does not prevent surgical shock nor the train of later nervous impairments so well described by Mumford. Anoci-association is accomplished by a combination of special management of patients (applied psychology), morphin, inhalation anesthesia, and local anesthesia.

"In operations under inhalation anesthesia the nerve impulses from the trauma reach every part of the brain—the cerebrum that is apparently anesthetized as well as the medulla that is known to remain awake —the proof being the physiological exhaustion of and the pathological change in the nerve cells.

"But if the nerve paths connecting the field of operation and the brain be blocked, then there is no discharge of nervous energy from the trauma, and consequently no exhaustion, however severe or prolonged the operation."

Many authorities do not hold with Crile in these conclusions. Nevertheless, there can be no question as to the result of their application when applied to modify the ill effects of anesthetic administration.

HEMORRHAGE.

Hemorrhage denotes the escape from the bloodvessels of all the constitutents of the blood. The recognized forms are: Arterial, venous, capillary, mixed, hemorrhage per diapedism, *i. e.*, diapedesis and extravasation through intact vessels; and hemorrhage per rhexin, *i. e.*, by actual rupture of the vessel.

Etiology.—Hemorrhage may be due to trauma or diseases of the bloodvessels, or it may result from neuropathic condition or the hemorrhagic diathesis (hemophilia).

Classification.—The principal forms of hemorrhage are as follows: *Epistaxis,* nosebleed; *hemoptysis,* hemorrhage of the lungs; *hematemesis,* hemorrhage from the stomach; *gastrorrhagia,* hemorrhage from the stomach due to lesion; *enterorrhagia,* hemorrhage from the bowels; *metrorrhagia,* uterine hemorrhage at other than menstrual periods; *menorrhagia,* immoderate hemorrhage at the menses; *ecchymosis,* hemorrhage infiltration beneath the skin or mucous membrane; *hemor-*

rhagic infarcts, infiltration of blood involving localized portions of a tissue or organ; and *hematoma,* blood tumor.

From a surgical point of view, hemorrhages are chiefly divided into (1) primary, immediately following division of the vessels; (2) reactionary, when the clot first formed is dislodged by force of circulation in recovery, imperfect ligatures, or other causes during the first few hours after operation or injury; (3) secondary hemorrhage, from sloughing of the vessels or too early absorption of ligatures several days after operation.

Symptoms.—The symptoms of hemorrhage are local and general.

Local Symptoms.—In the case of the larger arteries the local symptoms are recognized by bright red blood appearing in jets; in the case of veins the blood flows steadily and is dark, and in the case of capillaries it oozes. In ordinary wounds there is a combination of the three.

General Symptoms.—These are exceedingly important, because the flow of blood may be internal or at least concealed from external observation. They are recognized by rapid pulse, which becomes shallow and irregular, and finally so slow and faint as to be almost imperceptible. The face is pale and the skin moist and clammy, with cold perspiration. With continued profuse flow of blood unchecked, respiration becomes short and noticeably difficult. Roaring in the ears, light flashes before the eyes, fainting, and finally syncope ensues, which sometimes brings such a weakened action of the heart that hemorrhage ceases sufficiently to admit of recovery. When this does not occur, dyspnea, cessation of the action of the heart, and death may result.

Treatment.—The various methods commonly used in arresting hemorrhage are as follows: *Ligation,* tying of the ligature; *forcipressure,* grasping the vessel with a forceps; *torsion,* by twisting the vessel with forceps; *acupressure,* the passing of a needle under the vessel, bringing the ends above the tissues upon each side, and ligating in the form of a figure 8; *tourniquet,* passing a cord or bandage of sufficient strength around the parts and twisting until compression checks the flow of blood; *Esmarch bandage,* a rubber bandage wrapped about the part to make compression for temporary purposes, as for amputation of an extremity; *styptics,* drugs used to promote contraction of the vessels or coagulation of the blood; *constitutional treatment,* frequently required to bring the blood into normal condition, when as a result of disease or predisposition its coagulative properties are insufficient and the tendency to hemorrhage unusual; *direct transfusion of blood,* resorted to for the double purpose of overcoming the result of excessive hemorrhage and introducing into the circulation blood which will be more nearly normal for correction of the hemorrhagic tendency; *by intravenous infusion; proctoclysis,* rectal administration and *hypodermoclysis* (directly into the tissues), normal salt and other solutions are also introduced into the system to overcome both the effect of and tendency to hemorrhage; *heat, cold, position,* and *pressure* are useful adjuncts in arresting the flow of blood to an affected part.

Certain details of surgical technic belong more properly to text-books covering elementary surgical principles, but both immediate and secondary hemorrhages may be important features in many mouth and jaw operations. This is especially true in cases of hemophilia, when large, raw, periosteal surfaces are exposed, and direct control of minute vessels from which serious oozing may take place is exceedingly difficult or perhaps impossible, and for this reason it seems advisable to describe briefly, yet with necessary detail, the various methods of meeting these emergencies.

Preparatory Measures.—Careful examination of the blood, especially the hemoglobin, is always a safe procedure preliminary to every grave surgical operation, and is imperative whenever indications point to unfavorable blood conditions. Sometimes these cannot be satisfactorily overcome, and the necessity of immediate operation is so urgent as to preclude corrective attempts. When permissible, tonics, good hygiene, and nourishing food may be greatly beneficial. Tendency to hemorrhage may also be reduced by the administration of calcium lactate, or adrenalin or suprarenal extract, for several days before operation. All these have been employed with more or less satisfactory results. The possibility of hemophilia should be recognized by a careful study of family history and records; and questions should be asked to determine whether other members of the family have been bleeders. Swelling of the joints is almost constantly present in these individuals, and this indication, if sought for, may at least serve to place the operator on his guard.

The coagulation time of the blood of the patient should be taken before operation. In this way much danger may be avoided. The author has found the Boggs coagulometer very satisfactory for this purpose. Its use should be a routine measure in all cases wherever possible.

Treatment of Grave Hemorrhage.—It is assumed that the operator has made careful incisions, as elsewhere described, of such form as to favor the firm retention of gauze packing if required, and that he has carefully ligated all vessels of sufficient size to be consequential factors. Under these circumstances hemorrhage which cannot be controlled by ligature, direct application, or packing necessitates the employment of other more general measures.

The *position* of the patient by raising the body or the head of the bed may be helpful. *Clamping* or *ligation* of the external carotid, the facial and lingual arteries will be described later (Chapter VI). *Cold applications* in the form of ice packs, cloths wrung in ice-water and placed about the head, face, and neck and heat applied to the extremities, are sometimes helpful expedients. *Compression with rubber bands around the arms* close to the shoulders and the thighs near the hips will be described later (Chapter VI). For *internal medication*, ergot administered internally, ergotin hypodermically, powdered ferropyrin

in 20 per cent. solution, and other similar remedies have been quite generally used and recommended. In the author's experience, however, they are not sufficiently effective to meet the requirements of surgical mouth wounds in serious cases. Calcium lactate, 5 to 20 grains every three of four hours by mouth, supplemented by thirty drops per rectum once or twice daily, seems to increase the coagulability of the blood appreciably. In the author's cases, when hemorrhage has been so controlled by packing that only a slight oozing of blood can take place, thus allowing a period of several days to get control of the blood conditions without serious injury to the patient, treatment of this kind has proved to be exceedingly beneficial.

Adrenalin (1 to 1000) given internally in 10- to 30-minim doses every two or three hours also has a beneficial effect, and when hemorrhage is more profuse, prompt action may be secured by the hypodermic injection of 10 to 20 minims. *Pituitary extract* is now highly recommended as having a prompt, more powerful, and longer continued effect than the adrenalin. *Gelatin, 2 per cent. to 3 per cent. in normal saline solution,* given by hypoderinoclysis, is among the valuable remedies; but since attention has been called to the frequency with which tetanus has followed this use, extreme care in the sterilization of the gelatin solution should be taken.

Coagulose (Hemostatic Ferment).—Coagulose, a blood serum obtained by precipitating hosre serum by means of a suitable mixture of acetone and ether, is fully as effective as fresh serum. It is supplied in 15 c.c. glass bulbs which contain 0.65 gram of the desiccated powder, equivalent to 10 c.c. of blood serum, and can be used to advantage for local application to staunch persistent oozing of blood, or by injection, to increase coagualbility. The author has found it very useful in a number of cases of serious hemorrhage. The great advantages are that this preparation does not deteriorate with ordinary care for a period of one year, and that it is always ready for immediate use.

Thromboplastin.—Thromboplastin is tissue juice made from brain and thromboplastin solution. It is claimed that it gives, upon local application, just the necessary properties to promote coagulation. *Thromboplastin hypodermic* is used hypodermically for the same purpose. The author's experience with these remedies is confined to a few cases and is by no means conclusive. Theoretically, however, they promise much usefulness.

Direct Transfusion of the Blood.—The introduction of blood directly from the artery of a healthy person into the vein of one affected by an uncontrollable hemorrhage, or suffering from the effect of excessive loss of blood, is the best measure for extreme cases.

The technic of the operation as performed by Crile and described in concise form by Brewer is as follows:

"The recipient and donor are placed on two tables and their arms prepared in the usual manner. Under cocain anesthesia the radial

artery of the donor is exposed for about two inches and ligated at its distal extremity. A temporary clamp is next placed on its proximal end and the artery divided near the ligature. The redundant layer of the adventitia is drawn outward and cut off, and the vessel threaded through the lumen in the cannula (Fig. 15). The lumen of the vessel is then grasped by thin equidistant mosquito forceps and drawn backward over the distal end of the cannula, forming an inverted cuff with intima downward. This is held in place by a ligature of fine silk placed over the second groove. The vein of the donor is prepared in the same manner, its lumen exposed by three small clamps, and drawn over the inverted arterial cuff on the cannula. The two are secured in place by a second ligature placed over the first groove, which securely holds the vessels in contact. The temporary clamps are next removed and the blood allowed to flow into the vein of the recipient. The flow at first is often slow, owing to the contraction of the artery from exposure. The application of wet compresses at a temperature of 108° to 112° F. will generally bring about relaxation of the arterial walls, and a vigorous flow of blood follows, which causes marked pulsation in the vein.

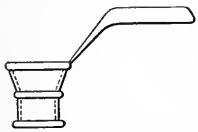


Fig. 15. — Crile's transfusion cannula. × 2. (Brewer.)

"The above technic, while not particularly difficult to one who has had an opportunity of rehearsing the operation either upon an animal or the cadaver, is often attended by certain embarrassments, especially in young children."

Brewer simplifies the operation by the use of glass tubes shown in Fig. 16, which are sterilized, dipped in melted paraffin, and allowed to cool. The paraffin which adheres to the inner surface he has proved by experimentation upon dogs will eventually prevent coagulation of the blood. He describes his operation as follows:

"The technic of this operation is simple, and consists in exposing the radial artery, dividing it, drawing the proximal end over one extremity of the glass tube and securing it by a silk ligature, then introducing the opposite end of the tube into the proximal end of a divided vein and securing it in the same manner. As soon as the temporary clamps are removed from the vessels, blood is readily transfused from one individual to the other."[1]

Dr. Robin Ottenberg, of New York,[2] describes his method of direct blood transfusion as follows: "It consists in the use of a small silver ring whose surface has two grooves. The ring is held by a self-retaining spring forceps, which greatly facilitates the procedure. The cut end of one of the divided vessels to be anastomosed is pushed through the ring and turned back over it like a cuff (Figs. 17, 18 and 19). This

[1] Brewer: Text-book of Surgery, pp. 151 and 152.
[2] Annals of Surgery, April, 1908, pp. 486 to 488.

cuffing is very easily done if the open lip of the vessel is caught at three points in its periphery by three tension sutures of fine silk.

"This cuff is then tied in place by a piece of fine silk in the posterior groove, and the other vessel is pulled over it. Then at once the two vessels are fastened together, intima to intima, by two fine pieces of silver wire, which fit into the two grooves." (The instruments used are shown in Figs. 20, 21 and 22.)

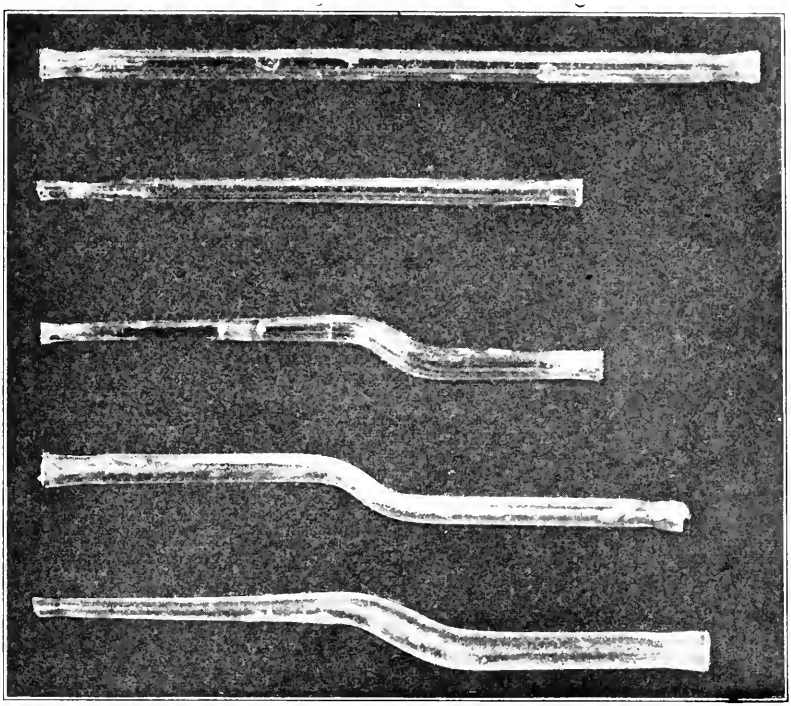


FIG. 16.—Brewer's glass cannulæ for direct transfusion, showing paraffin coating on inner surface.

Indirect Transfusion of Blood.—Percy[1] recommends the following method: "The tube consists of a glass cylinder 4 cm. in diameter, with a cannula leading from one end, the other end being drawn out into a tube about 1 cm. in diameter to which a Y connection is made. To one arm of the Y, a rubber tube is attached for suction to aid in filling the tube, and to the other arm a rubber bulb is connected to aid in injecting the blood.

"The cannula part of the tube is so constructed that it can be inserted directly into the vein of the donor and then the recipient. (See Fig. 23.)

[1] Surg., Gynec. and Obst., September, 1915.

"The dangers of transfusion are two; *i. e.*, immediate and delayed. The immediate dangers are embolism either from air or clotted blood,

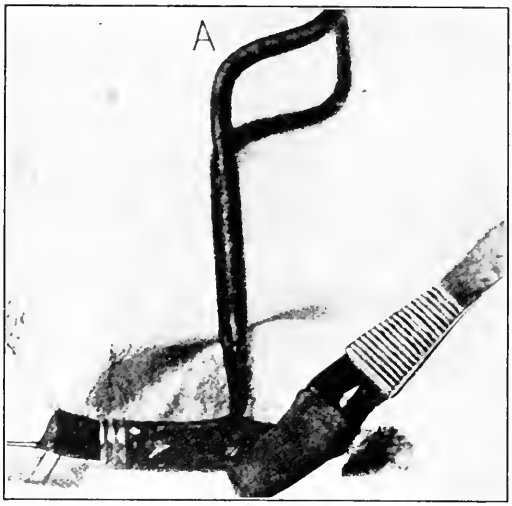


FIG. 17.—Ring and self-retaining forceps in place, and vessel prepared for turning back to form cuff.

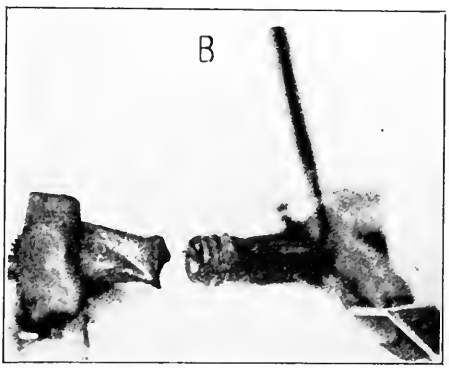


FIG. 18.—Cuff tied ready to have vessel pulled over it.

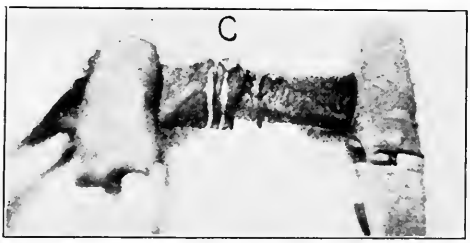


FIG. 19.—Vessel drawn over cuff and tied ready for transfusion of the blood.

or acute dilatation of the heart consequent to such rapid inflow of blood that the recipient's heart is overwhelmed. The delayed danger is that from hemolysis, which danger cannot always be eliminated by the most careful tests prior to the operation.

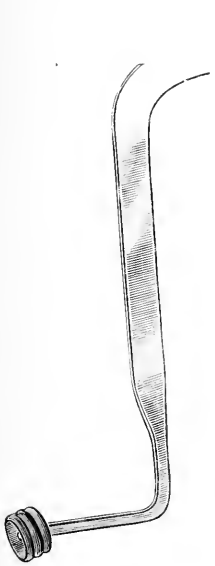


Fig. 20

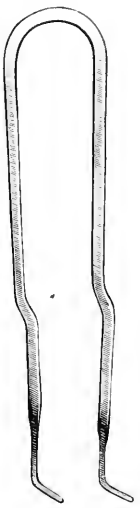


Fig. 21

Fig. 22

Figs. 20, 21 and 22.—Ottenberg's instruments for blood transfusion.

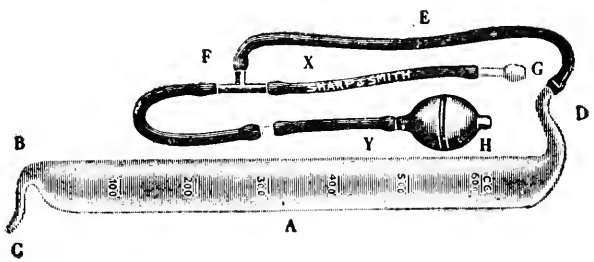


Fig. 23.—Instrument used in indirect method of transfusing blood. Percy's modification of the Brown tube.

"To guard against hemolysis preliminary tests should be made except when emergency conditions are prohibitive. All syringes, glassware and other instruments used in the tests are dry sterilized. Twenty c.c. of blood are drawn from a vein of the donor, and a like amount from a vein of the recipient. Each is subjected to the following treatment: Five c.c. may be placed in a test-tube containing glass beads, and the tube shaken for five minutes. This defibrinates the blood with result-

ant corpuscles. The remaining 15 c.c. of blood are placed in a test-tube on a slant and kept at room temperature until clotting has taken place. Then it is placed in an incubator at 37° C. to facilitate precipitation of the serum. The defibrinated blood is washed and centrifuging in physiological salt solution of the washed corpuscles, a 5 per cent. suspension is made by taking 0.5 c.c. of corpuscles and 8.5 c.c. of saline. Of this 5 per cent. emulsion of red corpuscles 0.5 c.c. is used, the cells of the donor are treated with a serum of the recipient and the cells of the recipient are treated with the serum of the donor. Control of the saline corpuscles of both are made.

"If the blood cells remain as a layer in the bottom of the test-tubes and there is a clear, nearly colorless fluid above, or if the tube, when shaken, be quite cloudy and not transparent, there has been no hemolysis. If there are no red cells present as a layer, or if the shaken tube is clear, there has been hemolysis of the red cells. The two control tubes should show no hemolysis. If they do, there has been an error in technic.

"*Preparation of Tube.*—The tube should be cleansed by washing with water, alcohol, and then with ether, and, after it is perfectly dry, two ounces of melted grocer's paraffin is poured into the tube through the upper end. It is then wrapped in a towel and placed in a steam autoclave for fifteen minutes under fifteen pounds of pressure, after which, with sterile rubber gloves over the hands, the tube is rolled around while cooling so that every part of the inside is covered with melted paraffin and any excess allowed to run out of the large end (*D*). Care should be taken not to allow the cannula to become plugged with paraffin. If it does, the tip is warmed over a flame and the paraffin allowed to run back into the tube. Sterilizing the rubber tubing, glass Y, and mouth-piece is done by placing them in a towel and autoclaving in the same way and at the same time as the transfusion tube, or boiling them for twenty minutes. The atomizer bulb is thoroughly washed with alcohol to sterilize it. When ready to use, the connections are all made and two ounces of sterile liquid paraffin aspirated into the tube through the cannula by means of suction at the mouth-piece.

"*Technic of Transfusing the Blood.*—The arms of both the donor and the recipient are prepared as for surgical operation. An ordinary blood-pressure apparatus placed about the arm and pumped up to 60 to 80 mm. of mercury, depending upon the rapidity with which the blood flows, makes an excellent constrictor. By this means the venous circulation is impeded, but not the arterial.

"Under local anesthesia, using 0.5 per cent. novocain solution intradermally, an incision is made over the cephalic vein just above the elbow on both the donor and the recipient, and a ligature placed about the vein in its proximal portion in the donor and in its distal portion in the recipient. Small Carrel clamps are placed on that portion of the vein

away from the ligature in each patient and a longitudinal incision 3 mm. long made through all coats of each vein midway between clamp and ligature. Small retention clamps are placed on the two edges of the incision in each vein in order to hold them open. The cannula is placed, pointing distally into the vein of the donor, and the Carrel clamp released from the vein. By means of suction at the mouthpiece, venous blood is drawn into the tube up to the required amount. The blood is well protected from the sides of the glass by the paraffin coat and from the air by the liquid paraffin which floats over and completely covers the blood. As soon as the tube is filled, which in our experience averages about three and one-half minutes to withdraw 600 c.c. of blood, the aspirating tube is clamped, the cannula removed from the vein and the small clamp reapplied to the donor's vein.

"The cannula is now quickly placed in the lumen of the vein of the recipient and the Carrel clamp released. The blood will now flow into the vein of the recipient toward the heart, the velocity of which flow may be controlled by careful pumping of the rubber atomizer bulb. As soon as it is evident that the blood is flowing properly, an assistant may release the constrictor from the donor and ligate the vein distally to the opening from which the blood has been taken. Not more than five minutes should be utilized in obtaining the blood, nor more than five minutes in injecting it. The length of time required to fill the tube with blood varies with different donors. It is well to have two tubes ready, so that if it is found that the first tube fills slowly, taking more than five minutes to get the required amount, the process may be repeated with the second tube, aspirating only the remainder of the required amount of blood." 500 to 850 c.c. of blood may be given at one time.

Paraffin seems to be the best anticoagulative agent for purposes of transfusion.

Herudin (leech extract), the citrate of sodium, and the metaphosphate of sodium have sometimes been satisfactorily employed for this purpose.

Intravenous Infusion of Normal Salt Solution.—This has a prompt effect upon the circulation. When a large quantity of blood has been lost it quickly supplies the circulating medium for the vessels and for heart action, gives immediate general stimulation, and is of material assistance in helping to combat toxic elements. While not so completely efficient in grave conditions of shock, collapse, and uncontrollable hemorrhage as the direct transfusion of blood, its simplicity and the readiness with which it can be performed without preparations which may involve delay make it a useful therapeutic measure that is more powerful than other methods of saline administration. The apparatus used is very simple (Fig. 24), and may be even more so in emergency, as an ordinary funnel attached to rubber tubing and an eyeglass dropper can be utilized. A superficial vein is exposed. Usu-

ally the median cephalic or basilic vein is chosen. Compression for a few moments causes the vein to become prominent and facilitates the operation. A short incision is made, the vein cleared and ligated above the point of the ligature, the cannula is introduced through a small incision which is made for the purpose, and fixed in position by a second ligature. Great care should be exercised to make sure that both tube and cannula are filled with solution before introduction to prevent air being forced into the vein.

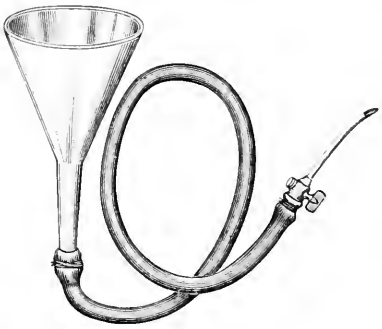


FIG. 24.—Funnel and tube for intravenous injection. (Brewer.)

The temperature of the sterile salt solution should be from 110° to 118° F. It should be slowly introduced unless there be pressing need of haste, and a quantity which may vary from 1 to 4 or 5 pints allowed to flow into the veins, this being measured by the nature and exigencies of the case and the effect upon the patient. Normal salt solution may be prepared by adding 130 grains of pure sodium chloride to one quart of sterile water.

Roswell Park's Balanced Physiological Solution is as follows: Sodium chloride, 0.09; potassium chloride, 0.03; calcium chloride, 0.02; sterile water, 100.

Hypodermoclysis.—Hypodermoclysis is the subcutaneous injection of saline or other solutions in large quantity. For this purpose an irrigator connected with a rubber tube having a long aspirating needle attached is used. Both the apparatus and the solution must be carefully sterilized. The aspirating needle is thrust through the skin into some fleshy part of the body, such as the abdomen, thorax, thigh, buttock, etc.

The skin is first cleansed with alcohol. One or two pints of normal salt solution are allowed to infiltrate the tissues. The distention of the parts immediately surrounding the needle point is reduced by gentle massage, which facilitates absorption. This treatment is usually sufficiently marked and prompt for ordinary cases, and has the advantage that any capable nurse may employ it instantly upon indication

for its use. Thus, the frequently grave delay of waiting for a surgeon capable of performing the more serious operative procedures incident to the methods of blood transfusion or saline intravenous infusion is avoided.

Proctoclysis.—The slow, drop-by-drop introduction of normal salt solution into the rectum or colon, a period of thirty minutes or one hour or more being required for a pint or quart, is a valuable remedy in reduced systemic states from long-continued fevers, intestinal diseases, and kindred conditions. It is also used in postoperative treatment to replace fluid lost from the circulation through hemorrhage, to supply active general stimulation, to relieve thirst following anesthesia, and to give a generally soothing effect. The addition of small quantities of coffee or whisky adds materially to the beneficial result. The introduction of saline solutions during the continuance of grave hemorrhage is objected to because it is claimed that the flow of blood is increased thereby, but when the hemorrhage has been checked it sometimes gives marked assistance in recovery.

Hemophilia Treated by Transfusion.—The following cases have been selected for description because of their features of special interest:

Case I.—Francis C. Allen has described the case of a boy, aged twelve years, who entered the hospital with a history of having bled from the mouth for four days previously. The bleeding had been profuse.

On admission, the patient was comatose, very pale, the skin was flabby and waxy, and a thin stream of blood was oozing from the mouth.

He was treated for two days with various drugs and with saline solution subcutaneously. The oozing continued, and the boy became weak and more deeply unconscious. The hemoglobin on the day of admission would not register on the hemoglobinometer, which does not register below 10, but the resident physician estimated it as 5.

The second day after admission, with an uncle of the child as the donor, a small amount of blood was transfused, but how much it was impossible to state. During the operation the boy's mental condition changed, and he became bright enough to complain of pain and to call the doctor hard names.

Two days after operation the hemoglobin had risen from 5 to 14, and the red cells from 1,060,000 to 1,240,000. The bleeding stopped after the transfusion, but recurred slightly at intervals for the next five or six weeks. The hemoglobin continued to increase.

On June 4, one month after admission, the hemoglobin registered 68, and the red cells 3,930,000. The boy was discharged in good condition, the only thing observable being that the teeth were carious and very irregular. It was almost impossible to ascertain the source of the bleeding; at times it seemed to come out of the teeth themselves, two of which were mere shells; at other times it seemed to come from the edges of the gums.

The boy has been back to the hospital three or four times since. During the following winter he was admitted with hemoglobin registering 15. Blood was not transfused on this occasion, but he was treated medically. The hemoglobin gradually rose.

Case II.—Report of case of Dr. Cobb, Medical Officer in Command, United States Public Health and Marine Service, Milwaukee.

C. B., aged twenty-two years, born in United States, admitted to St. Mary's Hospital, Milwaukee, September 6, 1909. Discharged December 10, 1909, recovered.

Family History.—There is a distinct family history of bleeders. Grandfather on mother's side is living and is a bleeder. All of six sons of his mother's sisters are bleeders. One brother of this patient bled to death, and his other brother is a bleeder. Today, September 10, blood count, red corpuscles, 2,250,000; white corpuscles, 13,125; hemoglobin, 35 per cent.

When admitted had foul tongue, temperature 101°, and muddy, yellowish skin, typical of infection. Tumor in iliac fossa which gradually increased in size until September 4.

Operation.—An incision about four inches long was made down through the abdominal muscles to the tumor. It had the appearance of a hematoma. A trocar was inserted and pure blood returned.

The next day a blood count was made, which showed 15,000 whites, 2,400,000 reds, and hemoglobin, 50 per cent. On September 6, hemoglobin, 40 per cent.; September 9, red blood count, 1,800,000; whites, 15,900; hemoglobin, 28 per cent.

The tumor increased rapidly in size after the operation and oozed slightly from the day of operation. By September 10 the tumor was noticeably bulging through the wound. During the night of September 13 the blood began to spout in a fine stream. To control the bleeding a median incision was made in the abdomen large enough to admit the hand. Through this an assistant controlled the common iliac artery. Then the tumor was hastily laid open and the great mass of black, clotted blood turned out. With gauze ready to pack, the iliac artery was released. There was no gush of blood, as was expected. There was no damage to any large bloodvessel, but there was rapid oozing from the walls which filled the tumor sac. The sac was firmly packed, the median wound closed, and the patient returned to bed.

When the first packing was removed the wound was filled with ferropyrin. This was continued until September 24. The patient was given calcium lactate in maximum dosage up to September 20. On the latter date we began the subcutaneous injection of 100 c.c of a 2 per cent. gelatin solution. This was given every day. Still the patient bled every day some time between one and five. October 1, gave 3000 units of antidiphtheritic serum. No change. Dr. G. V. I. Brown suggested the Crile transfusion. Dr. John L. Yates, of Mil-

waukee, performed the operation of blood transfusion by the Crile method October 4. The effects were immediate. The red count was 5,000,000 on the morning of October 5. The hemoglobin was 75 per cent. The patient did not bleed again. In five days the red count was 5,400,000 and hemoglobin 92 per cent. The wound cavity, which extended to the kidney above and filled the iliac fossa, had showed no tendency to heal as long as there was bleeding, but it began to fill in rapidly after the transfusion.

Patient bled thirty-two days. Discharged December 10, 1909.

The following is a personal report of a case of subcutaneous injection in small quantities of human blood in spontaneous hemorrhage of the newborn, by Dr. A. W. Myers, of Milwaukee.

At noon on June 20, when the child was thirty-two hours old, a large stool was expelled composed entirely of tarry blood clots. This was repeated at 2, 3, 4, 5, 6, and 8 P.M. At 4, 6, and 8 P.M. the expulsion of the bloody stools was accompanied by vomiting of considerable quantities of clotted blood.

During the night the child slept quietly until 4 A.M., when there was a bloody stool with vomiting of blood. This was repeated at 7 A.M., and at 10 and 11.30 A.M. there were bloody stools without vomiting.

When seen at noon of June 21 the child's condition seemed almost hopeless; the weight had fallen to 4 pounds 8 ounces, the mucous membranes were very pale, the skin was colorless. The cord was normal, no bleeding occurred at this point, and there were no hemorrhages into the skin or the visible mucous membranes.

Three c.c. of blood were drawn from a vein of the mother's arm and quickly injected into the subcutaneous tissues of the baby's buttock before there was time for the bood to coagulate in the syringe. This was done at 12 M.

At 2.30 P.M. a stool was passed containing rather old-looking clots and a small amount of fresh blood.

At 4.30 P.M. a second injection of maternal blood was given into the other buttock. There was absolutely no more bleeding.

The child was put to the breast and nursed well after the first few times. There was no more vomiting, and the following stools presented the typical meconium character, gradually changing to the milk-stool appearance in a few days.

The blood injected was quickly absorbed, and a few hours afterward the site of injection could be recognized only by the needle puncture in the skin.

The subsequent history of the child was uneventful. On June 23 the weight was 4 pounds 10 ounces, on July 2, 5 pounds, and on July 16, 6 pounds.

Schloss and Commisky[1] report 7 cases of spontaneous hemorrhage

[1] Am. Jour. Dis. of Children, April, 1911.

in the newborn treated in this manner, of which 6 recovered and 1 died. The fatal case was in an infant in a moribund condition from multiple hemorrhages for eight days.

The ease with which this method of treatment can be carried out under any surroundings, and the brilliant results reported by Schloss and Commisky, will do much to commend it to all who have frequently encountered this alarming condition.

Welch has reported 12 cases with hemorrhage in the newborn successfully treated by the subcutaneous injection of human blood serum.

Upon two occasions the author has had 2 to 5 c.c. of blood taken from his own arm and injected into the buttock when newly born infants' blood failed to coagulate after hare-lip operation.

There was more or less induration surrounding the point of injection in each case, but the hemorrhage ceased.

If time should prove that human blood may be spontaneously injected in infants without harmful results, and with prompt benefit, such as the cases thus far reported have received, it would be a great step forward in the treatment of many other affections as well as spontaneous hemorrhage in the newborn. The direct transfusion of blood by even the simplest method is difficult and a more or less slow process because of the smallness of the infant's vessels, and even the preparation of serum requires more time than is necessary for the subcutaneous injection of blood as described. The time limit alone may decide the question of life or death in a critical situation.

Experience with many patients in which low blood coagulation has been a serious factor has impressed upon the author's mind the necessity for familiarity with every means of controlling hemorrhage. Many times this has meant the saving of life. The several methods of blood transfusion and other treatments are therefore presented in this light.

SHOCK.

Shock is defined as a depression of the vital powers caused by painful injuries or strong mental emotion. According to Crile, "the central nervous system is in shock whenever it has been subjected to a sufficient afferent stimulation to produce pathological alteration of function."

Shock usually follows immediately upon the reception of an injury, but may appear some time after. The author believes that the effect of deferred shock in long-continued operations in dental chairs is much greater and more frequent than it appears to be, and that because the symptoms are not immediate their real cause is not recognized.

Etiology.—Psychic Causes.—The physical manifestations of purely mental impressions as exemplified in shock are modified by many conditions related to bodily health, temperament, and other controlling

factors; thus, sudden fright, the effect of bad news, the stirring of some memory center through the senses, might be slight or serious, or even cause syncope and death, according to the temperament or condition of general health of the individual, or of some vital organ.

Operative Causes.—The shock from surgical, operative, or other injuries likewise is in a general way proportionate to the character and extent of injury, subject to modifying conditions, so that sometimes a very slight traumatism or surgical operation will produce symptoms of severe shock, while serious injuries may pass with but slight disturbance.

Grave accidental injuries accompanied by fright, such as railroad or similar accidents, almost invariably cause severe shock.

Surgical shock is aggravated by the influence of *predisposing potent factors, lowered vitality, extremes of age* (infancy and old age), *malnutrition, exhaustion* (as from chronic disease, overexertion, mental or bodily suffering, etc.), *diseases of the blood, kidneys,* and *heart, tuberculosis, syphilis, chronic* or *acute nervous states,* and *pregnancy.*

Direct Factors.—It has long been known that certain classes of injuries are attended with marked shock, such as injuries of the viscera, testicle, and much lacerated wounds of the trunk and extremities.

Crile and Lauer, from notes on 5800 major operations, enumerate the factors in shock as follows:

"(*a*) Psychic excitation, such as fear, foreboding, etc. This has seemed to be a more powerful factor than is usually considered.

"(*b*) Hemorrhage, also a self-evident factor, and often very difficult to estimate closely.

"(*c*) Cold. The depressing effect of lowering the body heat, as in exposure to cold on battlefields, undue exposure in the operating room, and many physiological experiments, is well established. In practice, Crile sometimes places the patient on a hot-water bed, adapted to the operating table.

"(*d*) Acute and chronic infections. In these there is a marked physical disturbance of many parts of the body, and certainly not the least is circulatory mechanism."[1]

The primary and essential factor in shock is an effect upon the vasomotor centers, evidenced by lowered blood-pressure. The resulting loss of vascular tone in the arteries with correspondingly diminished activity of the heart causes an unequal distribution of the blood.

As a result the abdominal veins become distended, the right side of the heart engorged, and because the blood becomes lodged in the paralyzed and the dilated venous system there is comparatively little blood circulation. This in turn acts upon the central nervous system and results in impairment or cessation of its functions. Crile's experiments on dogs, corroborated by study of human cases, has shown the

[1] Practical Medicine, Series 11, 1906, p. 82 (after Jour. Am. Med. Assn., June 17, 1905).

effect of blood-pressure on respiration. In 90 out of 103 experiments he found that respiratory failure was the actual cause of death, and that, contrary to the generally accepted opinion, the heart was the one factor most to be depended upon; that heart weakness was due to the reduced amount of fluid in its cavities more than to any direct effect of the shock, thus giving a practical basis for treatment, which has been fully corroborated by the results of blood transfusion in both animals and man.

Some *experimental studies on shock and hemorrhage* are reported by F. C. Mann[1] from the Mayo Clinic.

In a normal dog 66 per cent. of the blood can be obtained from the femoral and 10 per cent. from the heart, leaving 24 per cent. in the tissues.

In an animal in which the C. cord is sectioned, producing medullary vasomotor paralysis, 54 per cent. of the blood can be obtained from the femoral and 12 per cent. from the heart, leaving 34 per cent. in the tissues.

In an animal in which blood-pressure is depressed practically to zero by an overdose of ether, 46 per cent. of the blood can be obtained from the femoral and 13 per cent. from the heart, leaving 41 per cent. in the tissues.

In an animal in which the viscera have been exposed until the clinical signs of shock are present but in which the vasomotor reflexes are as active or even more so than normal, only 28 per cent. of the blood can be obtained from the femoral.

He concludes that the clinical signs of shock which appear after section of the abdomen and exposure of the viscera are due to a loss of circulatory fluid. This loss is not dependent upon any primary impairment of the medullary center and takes place at a point beyond the control of the vasomotor mechanism. The causes for this loss are apparently the same as those which determine the accumulation of fluid in any other irritated area and produce the signs of inflammation. The nervous system probably plays no greater part in the former case than in the latter. The condition is made grave when the viscera are exposed because of the great vascularity of the tissues involved.

Pike and Coombs'[2] conclusions from their experimentations are that:

1. When the cells of the brain and medulla oblongata are deprived of blood for a period of from ten to twenty minutes, a change in the staining reactions of the cells is demonstrable if the brain and upper portion of the spinal cord are removed some minutes after the circulation to the head has been restored.[3]

[1] Surg., Gynec. and Obst., October, 1915.

[2] The Relation of Low Blood-pressure to a Fatal Termination in Traumatic Shock, Jour. Am. Med. Assn., June 23, 1917.

[3] Gomez and Pike: Jour. Exper. Med., 1909, p. 11.

2. There is a greater susceptibility of these previously damaged cells to strychnin. Paralysis and failure of function from administration of strychnin during the resuscitation period occur more readily in the anterior (cephalic) portion of the central nervous system, which has been deprived of blood for a time, than in the posterior portion through which the circulation has been maintained continuously.[1]

3. Such damaged nerve cells will recover when a proper supply of oxygenated blood is provided. Respiration, blood-pressure and pulse rate soon become normal.[2]

In some cases collapse or complete prostration doubtless occurs rapidly from grave injury which appears to be the result of inhibitory reflex directly affecting the vagus. The foregoing more or less conflicting conclusions from experimental research with reference to hemorrhage and shock will undoubtedly be cleared up in the near future, as its relation to the vegetative nervous system and vagotonic conditions, and the influences which bear upon the balance of control between the sympathetic and vagus systems become better understood in the light of researches now well under way by many investigators. From a surgical operative point of view, however, the net result is much the same, for all conclusions point in the direction of better operative technic.

Symptoms.—All symptoms of shock have a certain resemblance, but for clinical convenience these are, so far as possible, arranged in graduated order from the milder to the graver conditions, as follows:

There is a feeling of weakness, giddiness, and slight nausea.

The appearance of the face is pale, with beads of cold perspiration upon the skin surface.

The extremities are cold, the pulse becomes weak and irregular, and syncope may occur, followed by partial or complete loss of consciousness.

Severe shock is indicated when restoration to consciousness is slow and there is a tendency to recurrence after the patient has been temporarily aroused, when the pupils are markedly dilated and slow in response to light reaction, and when the surface of the body is cold and clammy with perspiration and there is no response to warmth or rubbing, and when there is a marked subnormal temperature, and the pulse unusually weak, rapid, irregular, and compressible.

The profound unconsciousness of coma or delirium, subnormal, temperature of 97° F. or less, with unusual restlessness or great feebleness, relaxation of the sphincters, sighing, feeble, irregular, unusually slow or exceedingly rapid and shallow respiration, with eyes rolled upward and failure to respond to stimulus of any kind, are indications for grave prognosis.

[1] Stewart and others: Journal Exper. Med., 1906, pp. 176 and 248.
[2] Pike: Am. Jour. Physiol., 1912, xxx, 436–450.

Treatment.—Prophylactic.—In cases of accident or emergency there is often little opportunity for more than an attempt to overcome the direct evidences of shock. When it is possible to be more deliberate, the mental attitude of the subject should be kept in mind, and brooding over the operation or a gloomy outlook should be avoided so far as possible by surrounding the patient with persons who are cheerful, hopeful, and competent.

Especially with infants, too long a period of starvation must be avoided. Nourishment in moderate quantity should be given from one and one-half to three hours before operation, according to the age of the infant. Starving babies bear shock badly. In older persons, except those in feeble health, precaution of this respect is not so necessary. The hypodermic injection of morphin, gr. $\frac{1}{6}$ to $\frac{1}{4}$, with atropin, gr. 120 to 100, thirty minutes before operation, or similar injections of scopolamin, gr. $\frac{1}{100}$, morphin, gr. $\frac{1}{6}$, will relieve the nervousness and make it possible to secure complete anesthesia with less anesthetic, besides reducing the danger of inspiration of mucus through control of the activity of glandular secretion.

The operating room should be warm. It is the author's custom to have infants and young children lie upon a warm water bottle upon an operating table or upon his special table arranged with a hot-water tank to maintain continuous warm temperature. This table was designed, made and contributed by Dr. R. M. Hall, of the Milwaukee Children's Free Hospital, whose kindness has given much benefit to many children. With older persons the table may or may not be warmed. But the body should not be unnecessarily exposed to chilling during the operation. Every drop of blood that can be saved reduces shock to just that extent; every fractional part by which the amount of anesthetic given can be reduced not only reduces the immediate danger of shock, but leaves just that much less of the depressing toxic effect for the system to overcome afterward; every moment by which the time of operation can be reduced without undue haste, which might cause neglect of important operative procedures, and every traumatic effect in the handling of tissue, violence in sponging, or contact with important nerves that may be avoided, is just that much accomplished toward relieving shock of its grave features. The previous administration of stimulating drugs, such as strychnin or even whisky, the author believes to be disadvantageous, because if a time should come when stimulation of this character is actually required its effect cannot be relied upon.

After-treatment.—The patient should be covered with warm blankets and protected against chilling of the body when he is taken from the operating room to the bed, which should previously have been warmed with hot-water bottles. He is then wrapped in warmed woollen blankets and the bodily temperature is maintained with water bottles, with, of course, protection to prevent burning the body during unconscious-

ness. Normal salt solution, a pint by the rectum, containing whisky or coffee, serves to restore circulatory conditions and to supply lost fluid in the circulation. It is soothing, tends to reduce the thirst for water, and favors normal reaction in every way. Quiet, restful surroundings and encouraging assurance that all is well with the first signs of returning consciousness often serve to reduce excitement and favor rest and recovery.

A 5 per cent. solution of glucose may be substituted for other stimulants in proctoclysis. Burham[1] advises its continuous use when necessary and states that 300 to 500 calories a day may be introduced in this way.

Of all the many drugs that have from time to time been recommended, the hypodermic injection of strychnin appears to H. P. Cole[2] to find favor among the greatest number of surgeons (46 per cent.), but those in opposition to its use hold that under some circumstances strychnin rather aggravates than improves the condition in shock.[3]

Bandaging.—A firm bandage about the abdomen or bandaging the extremities, or Crile's pneumatic suit, may be employed to equalize the circulation and temporarily assist the heart. Except when contraindicated, the patient should be kept with the head low during recovery and the face turned upon one side to prevent inspiration of the blood or mucus. Additional advantage in a weakened state may be gained by raising the foot of the bed so that the body inclines with the head slightly downward.

Care should be taken that normal salt solution given by the rectum is maintained at a sufficiently high temperature. Murphy has proved that ordinarily a loss of several degrees occurs by the time the salt reaches the colon. Some one of the many forms of keeping the solution hot must be used, otherwise the effect may be to decrease rather than increase bodily temperature. The salt solution is best administered by the drop method, slowly, taking, if necessary, an hour for the administration of a pint of saline (p. 48).

When the effect of salt solution by the rectum is insufficient, it may be given by hypodermoclysis directly into the tissues (p. 48). A syringe point is made for the purpose after the form of a hypodermic needle, only somewhat larger. It is attached to the rubber tube connected with the vessel containing the salt solution, and is forced into the tissues in a fleshy part of the body. The absorption of the fluid is assisted by gentle manipulation of the tissue around the point. In cases where still more rapid reaction is required the intravenous injection of saline solution (p. 47) is indicated. Mummery recommends the intravenous infusion of a solution of adrenalin in normal salt

[1] Am. Jour. Med. Sc., September, 1915.
[2] Southern Med. Jour., June, 1909.
[3] Mummery, J. P. L.: Lancet, April, 1903.

solution, 1 to 20,000, at the rate of about 3 to 5 c.c. per minute, to be continued until blood-pressure remains at a safe level. Crile urges, and has demonstrated beyond question, the value of direct blood transfusion according to his method (p. 41).

Henderson[1] claims to have demonstrated that lack of carbon dioxide in the blood causes a lack of venous tone, and this lack of venous tone diminishes the amount of blood that reaches the auricles and, therefore, ventricles of the heart during diastole. He also states that even when the anesthetic appears to be sufficient, the sensitive nerves still note injuries and pain, and shock may be caused unless the anesthesia is profound. This means clinically that anesthesia should always be sufficient before operation and during operation. He claims that a lowered arterial tension improves rapidly when physiological saline impregnated with carbon dioxide is administered intravenously.

Henderson terms this condition of diminished carbon dioxide content of the blood acapnia (from the Greek *kapnos*, meaning smoke), literally a "smokelessness."

"1. Severe pain should never be allowed; it should be prevented by enough of the narcotic which seems indicated in the individual cases.

"2. Anesthesia should be complete both before beginning operation and during it.

"3. If shock occurs after operation or after other injuries, transfusion into the veins of physiological saline saturated with carbon dioxide should be done. Also, at any time during shock, air or oxygen, with moderate amounts of carbon dioxide, should be inhaled.

"4. Whenever there is likelihood of pain following the recovery of the patients from anesthesia, morphin should be injected to prevent it.

"5. However valuable strychnin injections may be as a stimulant to the nerve centers and as a stimulant to general metabolism to perhaps promote normal cellular activity, and perhaps, therefore, the production of a normal amount of carbon dioxide, excessive amount of strychnin as a cardiac and respiratory stimulant in shock should not be used. Large doses of strychnin, or strychnin repeated too frequently, seem to interfere with normal diastole of the heart and prevent the normal filling of the heart cavities and therefore the normal output of the heart into the arteries. Henderson seems to have shown that such cardiac stimulants cannot increase the output from the heart cavities.

"6. Digitalis would rarely be indicated, if ever, in acute shock. The greatest advantage of digitalis is in cardiac dilatation, and its best activity is in cardiac hypertrophy with dilatation."

[1] Jour. Am. Med. Assn., August 7, 1909, p. 461.

CHAPTER II.

PATHOLOGICAL DENTITION

- Causes
  - Predisposing
    - Defective embryonic development.
    - Perverted development.
    - Malnutrition.
    - Syphilis.
    - Rachitis.
    - Neurotic tendency.
    - Other diseased conditions.
  - Exciting
    - Arrested maxillary development.
    - Undue thickening and resistance of overlying tissue, causing pressure from crowns of teeth to react through the open ends of roots upon the dental papilla, thus giving direct irritation.
    - Malposition.

In considering pathological conditions coincident with irritation manifested during the period of tooth eruption in infants, it should be remembered that the germs of the first teeth begin to develop as early as the fifth week of embryonic life, that these are quickly followed by those of the permanent set, and that at birth the tooth follicles for both sets are present in the jaws in course of development.

During the period of tooth development of infants a high mortality, the prevalence of intestinal disturbances, skin eruptions, and spasmodic and other nervous affections are noted. The same tendencies appear at later periods, notably about the fifth, sixth, or seventh year, as the first permanent molars appear, and again when the second and third molars are endeavoring to erupt.

Kiernan, Talbot, Kirk, Upson, and others have called attention to the fact that these periods of stress frequently mark the time of the first manifestations of chorea, epilepsy, and other neurotic tendencies (p. 309).

The process of tooth eruption is related to these affections by direct irritation through pressure caused by resistance of the inflamed or thickened tissue, covering the tooth crown, forcing the sharp borders of the incompletely developed roots against the pulp tissue with its as yet unprotected nerves and bloodvessels.

Indirectly this irritation tends to reduce the bodily resistance to bacteria, disturbs digestive functions, and accentuates inherent tendencies to neurotic states (Fig. 25), now recognized as vagotonia.

All too frequently patients have been referred to the author with a history of having been under treatment for third molars that were expected to erupt, but instead, cancer was found on the site of the

inflamed tissue over and around the malposed teeth which had been allowed to progress beyond the reasonable hope of cure because of delay.

Symptoms.—The symptoms are local and general.

Local Symptoms.—Local symptoms are readily recognized in *infant* cases by the evident desire of the child to bite upon any substance it can put into its mouth, by the excessive flow of saliva incident to the unusual irritation, and by the appearance of the mucous membrane surface of the mouth in the region of the erupting tooth crowns, where it may be slightly swollen, red, and inflamed in appearance, or more often white, when the gum tissue has become tightly stretched across the incisal or occlusal tooth surfaces and toughened until unusually resistant.

FIG 25.—Erupting tooth.

Occasionally the mouth becomes so tender that the infant can with difficulty be made to take the nipple or bottle, and the characteristic stomatitis affects the membrane surface.

With *adults,* the local manifestation may be noted in the appearance of the cusps or crowns of teeth through the gum upon the surface of the alveolar ridges, or the gum may be swollen and tender from being bitten upon by the antagonizing tooth in the opposite jaw. Spasmodic contraction of the muscles of mastication may result from direct nerve irritation, or the inflammation may extend until surrounding muscles

and glands are involved, and cause temporary ankylosis, the degree of which may be slight, or sufficient to cause complete fixation of the mandible.

The swelling may be confined to the tissues in the region of the angle of the jaw, or include the parotid and submaxillary structures also. Pain may be continuous and severe, or be noticed only upon attempt to open the mouth. The tissues of the floor of the mouth and tongue may become infected and cause symptoms identical with Ludwig's angina, and thus endanger life through difficulty in respiration and swallowing.

General Symptoms.—In *infant cases* it is sometimes practically impossible to differentiate between some of the many expressions of disease that may be coincident with tooth eruption and other pathological affections to which such infants are prone.

Spasms, infantile paralysis, disturbance of the digestive tract, diseases of the skin and mucous membrane, trophic changes, meningitis, and affections of the spinal cord leading to muscular atrophy, etc., may be the result of predisposition engendered by direct nerve irritation, infection, or weakened resistance incident to tooth eruption; on the other hand, these may be due to other etiological agencies, therefore diagnosis is necessarily made by exclusion.

In *adult cases* malposed or supernumerary teeth are frequent causes of reflex pain (Fig. 26, and p. 310) and of other disturbances of similar origin, such as facial spasm, chorea, epilepsy, and kindred spasmodic affections, paralysis, sensory alterations, neuralgia, or trophic changes, which may be manifested in many different forms.

Such teeth may become encysted and thus occupy the central position in cysts that are sometimes of enormous size. Many serious pathological states may result from irritation and infection of the tissues surrounding teeth that are in course of eruption, especially if impacted or in malposition. Long-continued nasal and antral diseases have been proved to be due to malposed teeth in these situations. Blindness, deafness, tinnitus aurium, and other affections indicating interferance with some cranial nerve have been more or less frequently reported from the same cause. Local infection may occur, especially in the case of malposed third molars, that are unable to erupt and have a more or less complete covering of gum tissue remaining upon their crown surfaces. The accumulation of bacteria-laden secretions and débris is thus favored by the pocket which is formed between the gum and tooth surface. Aided by abrasion, swelling and other inflammatory symptoms result, which, once inaugurated from the center thus established, may readily enter the lymphatic pathways of the neck and lead to septicemia, pyemia, and other disorders of the blood and lymphatic systems. The final result may be grave or slight, according to the resistance of the individual and other factors upon which the prognosis of all such affections must depend. Figs. 26 to 42 are examples of such cases.

Diagnosis.—Infant Cases.—Erupting teeth in infant mouths are usually easily recognized by prominences upon the alveolar ridges and the appearance of the gum tissue over and around the erupting tooth crowns, which become dark and slightly swollen, or white if reduced to a toughened, resistant membrane.

Adult Cases.—With adults the diagnostic guides are: (1) Absence of a tooth without history of extraction or loss from other known cause, the possibility of other supernumerary teeth always being borne in mind in this connection. (2) Unusual fulness in the portion of the jaw in which the suspected unerupted tooth may lie. (3) Exploration with a smooth, sharp-pointed, stiff probe passed through the gum tissue and into the bone structure, which, in the process of

FIG. 26.—Skull with an unerupted cuspid tooth placed in the same situation as that in which it was found in the mouth of a man who suffered for many years with tic douloureux.

absorption incident to tooth eruption or during the effort of an impacted tooth to erupt, usually becomes more or less porous, and thus permits of the passage of the probe until it touches the hard, smooth, easily recognized surface of the tooth crown. (4) The *x*-rays.

In the third molar region differentiation must be made to exclude mumps, submaxillary or parotid inflammation from other cause, syphilis, ptyalism, tumors, true ankylosis, and other infectious diseases. The presence of the tooth is the determining factor, and the *x*-rays the final method of decision when other diagnostic efforts fail.

Treatment.—Treatment of Infants.—Give direct relief by cutting through the overlying tissue down to the erupting tooth crown. An attendant should hold the baby firmly, and by lowering its head induce it to cry. This immediately causes the mouth to be opened, so that

there is little difficulty in gaining access to the alveolar ridges. With a sharp-pointed bistoury or a surgical knife, protected by being wrapped

FIG. 27.—Impacted teeth in adult case. Deciduous teeth crowned through error on the part of dentist. Chronic disease in this region finally led to diagnosis with the *x*-rays.

FIG. 28.—Impacted cuspid in adult case, with an interesting history of neuralgic pain.

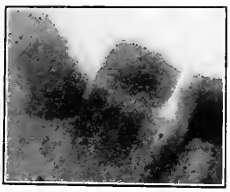


FIG. 29

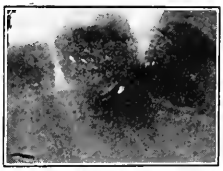


FIG. 30

FIGS. 29 and 30 show two impacted lower third molars in the jaw of a girl, aged fifteen years, who suffered great pain and other distressing nervous symptoms.

FIG. 31.—Two unerupted cuspids situated in the palate of a girl, aged twenty-two years.

with gauze, tape, or other material, the point alone being exposed, make an incision longer than the tooth is wide, if it be one of the anterior teeth; cut down upon the incisal surface, and follow it entirely across.

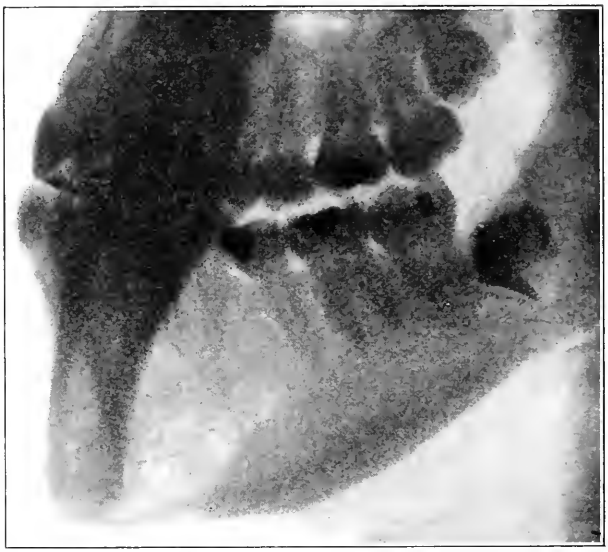


FIG. 32.—Radiogram of the mouth of a young woman, aged twenty years, showing an impacted third molar. In this case severe neuralgic pain in the head was relieved by removal of the impacted teeth.

FIG. 33.—Unerupted left cuspid near the orbit in the case of a man, aged twenty-six years. Maxillary sinus on left side involved.

Bicuspids and molars require crucial incisions long enough in each direction to include the cusps of the erupting teeth as shown in Fig. 43.

FIG. 34.—Teeth in course of eruption. This illustrates the difficulties encountered when teeth are crowded in the jaws.

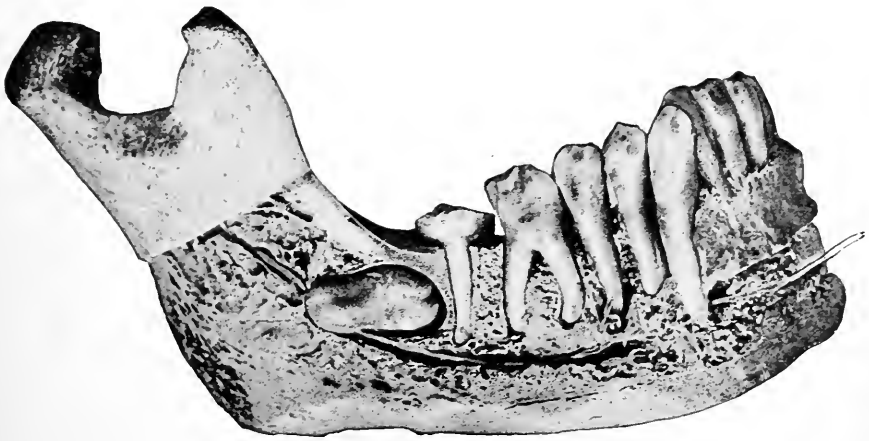


FIG. 35.—A view of an impacted lower third molar. (Cryer.)

Occasionally it is necessary to remove the entire portion of gum which covers the occlusal surfaces of the erupting teeth.

Treatment of Adults.—*Preservation of the Teeth.*—When malposed or impacted teeth are diagnosticated with the aid of the *x*-rays or

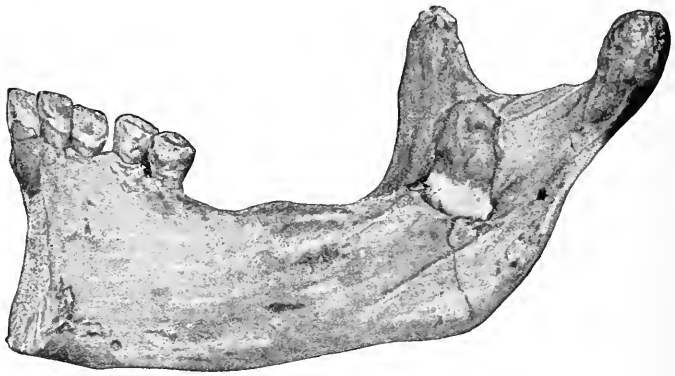


FIG. 36.—An uncommon impacted lower third molar. (Cryer.)

otherwise, it should be remembered that they need not necessarily be condemned, because, unless they are supernumerary teeth, each

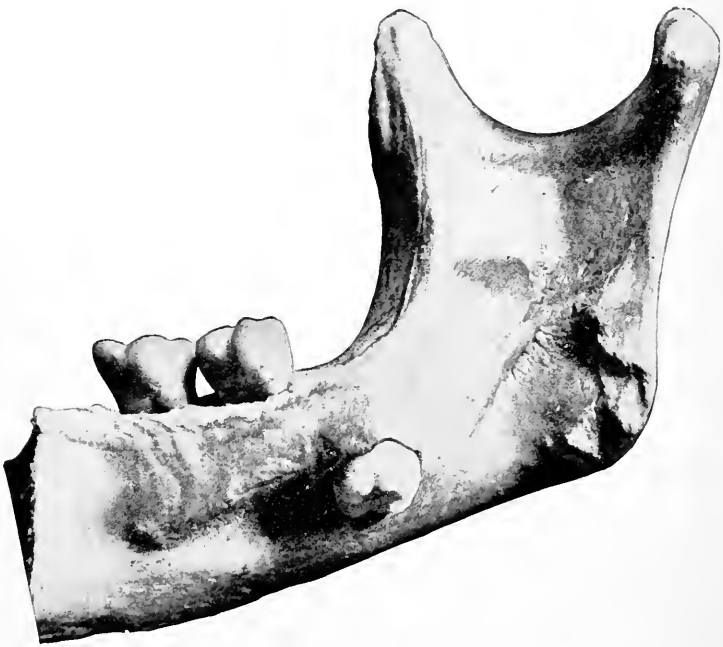


FIG. 37.—Showing an inverted lower third molar erupting into the submaxillary fossa. (Ottofy.)

one has its rightful place in the complement of the perfect individual. Usually such teeth are crowded out of place and their eruption is pre-

vented by insufficient or at least imperfect development of the jaws and dental arches. The proper remedy, therefore, except when some unusual circumstances contra-indicate such treatment, is to expand the dental arches and regulate the teeth in such manner as to give opportunity for the impacted tooth or teeth to erupt. When this is done, even with persons of quite advanced years, and the eruption

FIG. 38.—Showing tooth malposed in ramus of the mandible. (Cryer.)

of the teeth stimulated by methods well known to orthodontists, such teeth, unless very abnormally situated, can usually be brought into proper position quite satisfactorily.

Frequently upper third molars appear to erupt with their crown surfaces turned toward the cheek and apparently outside of the line of the upper dental arch. As a matter of fact, it is the arch that should

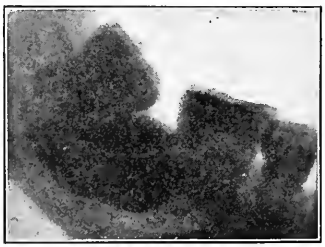


FIG. 39.—Impacted third molar below the second molar. (Cryer.)

be expanded out to the line of the third molars, thus giving them room to erupt in correct position. This at the same time restores to some extent the size of the nares, which under proper examination are often found contracted and otherwise deformed. Extraction of the teeth, while giving apparent relief, usually increases instead of decreasing the ill effects.

FIG. 40.—An impacted upper third molar. A similar condition found on the opposite side of the skull. (Cryer.)

FIG. 41.—Radiogram showing impacted canine. (Cryer.)

In like manner, lower third molars may be impacted, with the usual tipping forward of the crown with its occlusal surface turned toward the distal side of the second molar. Unless too firmly locked or too solidly embedded in the angle of the jaw to make such treatment practicable, they may sometimes be wedged away from the second

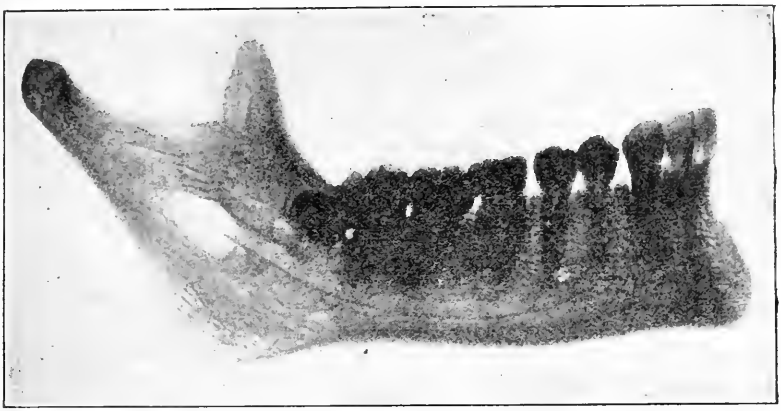


FIG. 42.—Radiogram of mandible, showing rudimentary fourth molar. (Cryer.)

molar sufficiently to free the mesial line angle from being locked under the contoured distal surface of the adjoining tooth, thus enabling it to come forward and upward into natural position.

The author does not urge extreme treatment in these cases, but he has abundant clinical reasons for believing that this aspect should always be considered before resorting to extraction.

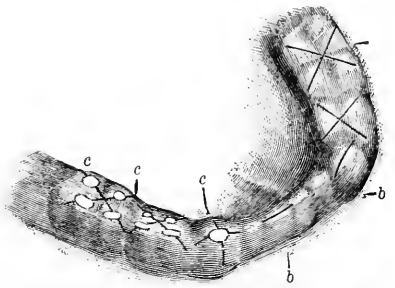


FIG. 43.—Lines of incision in lancing: *a*, over the molars; *b*, *b*, over the canines and incisors before eruption; *c*, *c*, *c*, over the molars and canines after partial eruption. (J. W. White.) Complete removal of the overlying gum tissue by an incision extending completely around the crown of the tooth is often required.

In adults a thick, resistant, bony covering sometimes lies between the tooth crown and the surface, which for some reason has resisted absorption. In these cases it is always beneficial and sometimes necessary to remove this bone structure with a surgical or dental

engine burr, so that eruption of the tooth may be facilitated, and that, if necessary, proper attachments be made to the crown for orthodontic purposes.

Treatment in cases of supernumerary, and also of geminated (twin) teeth must be determined by consideration of the cosmetic results as well as the effect upon underlying pathological and developmental conditions which may be influenced by extraction or retention. The time of correction is often an important factor in these respects.

Palliative Treatment.—Patients suffering from acute inflammatory conditions, due to erupting teeth, particularly third molars, frequently come for treatment in a state of great distress from pain, inability to open the mouth, and associated symptoms of local disturbance, together with rise in temperature and other general indications of the toxic influence of the infection. Although it may be apparent that the offending tooth must be extracted, the decision as to the time of extraction is a matter of much importance. A number of deaths have been reported from immediate operation upon cases during the acute inflammatory stage, and the presence of microörganisms in the blood appears to have demonstrated that the opening of bloodvessels incident to operation for removal of the impacted teeth has allowed the direct entrance of septic matter into the circulation and converted septic intoxication into true septicemia. The wiser plan would therefore be to await the subsidence of the acute symptoms in every case before undertaking operation. This, however, is not always practicable, because the danger involved from continued progress of the inflammation and infection may absolutely force drastic measures, even though they be adopted with full knowledge of the danger. In most cases, however, notwithstanding the usual urging of the patient from relief, the fixed jaw can be gradually opened by the use of a mouth gag with or without the aid of an anesthetic, and retained in at least a partially open position by the use of rubber corks, as indicated under treatment of ankylosis (Fig. 199, p. 372). With the mouth thus opened, it is possible to reach the seat of the inflammation, to draw off the pus from over and around the impacted tooth crown, to disinfect the mouth, and to make local applications, both intrabuccal and extrabuccal, for the relief of the inflammation. After this, extraction of the tooth may be accomplished with greater safety.

REMOVAL OF IMPACTED TEETH.

When unfavorable conditions which contra-indicate the immediate removal of impacted teeth have been overcome, or in the unusual cases which require operation without waiting for their subsidence, and when orthodontic methods for effecting correct eruption are precluded or inadmissible, the removal of such teeth is required.

The first principle in the removal of impacted third molars and other impacted teeth is that surrounding bone which may seriously

interfere with extraction should be removed before unusually forcible attempts are made with dental forceps. Unwise use of these instruments is apt to result in failure to extract the tooth, causing much unnecessary pain and discomfort or even serious injury to the patient. The crown of the tooth may be crushed or broken off, thereby increasing the difficulties of extraction; pieces of bone may be splintered in such manner as to cause necrosis, or the jaw bone may be fractured, as has been known to occur, especially when the so-called Physick forceps have been used.

The Danger of Such Operations.—On account of the anatomical situations of impacted third molars and other teeth, and the peculiar conditions under which their removal must be effected, the following definite dangers, in addition to those common to other surgical operative risks, must be anticipated:

1. The inspiration of blood. When the patient is deeply under a general anesthetic and lying in the prone position, blood may easily be drawn into the trachea in such quantities as to fill the bronchi and to flood the lungs sufficiently to cause instant death. Fatalities during mouth operations have not uncommonly occurred from this cause.

2. The inspiration of even small quantities of blood with bacteria-laden saliva may lead to inspiration pneumonia, and this may indirectly cause a fatal termination.

3. The immediate loss of blood, if unchecked, may be a serious menace to the vitality of the patient, or secondary hemorrhage may be difficult to control and be serious in its results. There is always also the danger of encountering a hemophiliac even when neither the pathognomonic swelling of the joints or the family history may be sufficiently indicative to serve as a warning. The dangers and difficulties attendant upon the management of a bleeder with wounds of this character in the mouth need hardly be elaborated.

4. The danger of general infection, which has been already referred to.

5. The danger of fracturing the jaw or causing temporary or permanent ankylosis or injuries to the nerves, that may leave serious postoperative effects.

6. Accidental failure to secure the tooth when forced out into the mouth, through which it may be swallowed or become lodged in the trachea or bronchi, causing suffocation and death. A number of such cases have been reported.

List of Serious Accidents of Extraction.—The following list of serious accidents of extraction, compiled by Dr. Julius Endelman, of Philadelphia, from the *Dental Cosmos*, up to and including 1904, and reported at the Fourth International Dental Congress, at St. Louis, gives an indication of the possibilities of these dangers. While by no means complete and not including accidents since that date, it is nevertheless sufficient to call attention to the frequency and the

nature and character of the most common of such accidents, as well as to the danger which attends them.

Removal of the floor of the antrum, 2; contraction of the muscles of the forearm and flexors of the fingers and adduction of thumbs, 1; tooth impacted in bronchus, death, 1; swallowing of tooth, 1; swallowing of a tooth, recovery, 1; fracture of maxillæ, 2; shock following extraction, death, 1; taking cold after extraction, infection, 1; migration of stump, 1; removal of tuberosity, 1; tooth in bronchus, recovery, 4; choked by tooth, death, 1; pneumonia caused by a tooth in bronchus, 1; paralysis after extraction, 4; dislocation of mandible, 1; suffocation by swallowing of a tooth during extraction, 1; third molar driven into jaw during extraction, 1; fracture of palatine bone, 1; purulent infection after extraction, 1; purulent infection following fracture of jaw during extraction, 1; broken piece of forceps left in jaw after extraction, infection, 1; death after extraction, infection, 3; tooth slipped from forceps into trachea, 1; forcing tooth into antrum, 1; hemorrhage, death, 1.

"Out of the total of 35 cases, 8 terminated fatally; 3 of the fatal cases were the result of infection directly traceable to foul instruments.

"There have probably been many similar accidents not reported, but cases of serious infection following extraction and death from this cause in a considerable number have undoubtedly not been reported."

Anesthetics.—In many of the less serious cases the injection of a local anesthetic seems to be sufficient. The author, however, fears local anesthesia chiefly because of the danger of carrying infection into the tissues and because the large quantity of the anesthetic required for the removal of deeply embedded teeth has often caused local necrosis and serious general effects. A marked instance of this occurred in an individual for whom an impacted third molar was removed under local anesthesia induced by the use of cocain and adrenalin injected by a high power syringe. Some hours after the operation loss of consciousness and paralysis ensued, with complete destruction of the usefulness of the life of the patient, presumably through an embolus forced into the brain.

Conductive anesthesia by blocking the nerve supply with novocain as described on page 20 and illustrated in the section on Anesthesia gives satisfactory results.

In this way not only is freedom from pain assured, but the adrenalin, or suprarennin effect, is shown in marked lessening of the hemorrhage. This facilitates both rapidity and accuracy in the performance of the operation.

When a general anesthetic is used, whether nitrous oxide gas, nitrous oxide gas and oxygen, somnoform, or ether, the operator should make certain that the anesthesia will continue sufficiently long to permit a complete operation without undue haste, and without the disadvantages attending such operations under imperfect anesthesia. Neglect

of this has caused many accidents which might have been avoided had anesthetic conditions been more favorable.

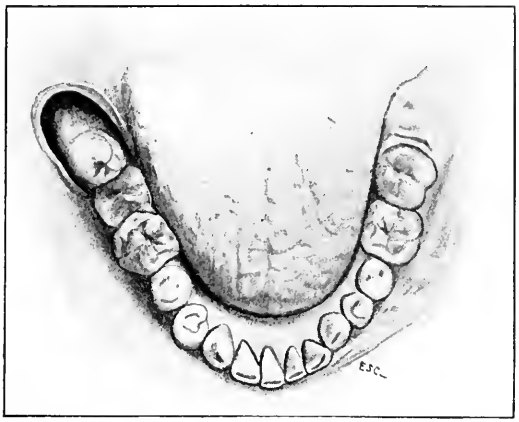


FIG. 44.—Impacted lower third molar, with overlying bone removed to facilitate extraction.

Asepsis.—Surgical cleanliness should be rigidly enforced and every effort made to avoid infection. Whenever possible, the teeth should

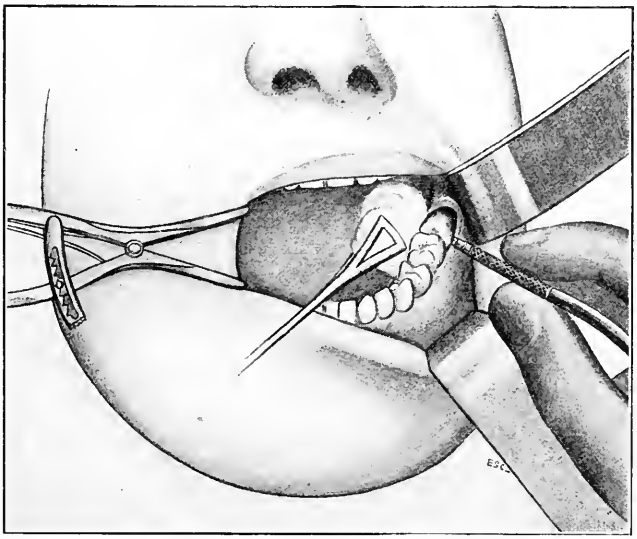


FIG. 45.—This shows the method of controlling the field of operation in extraction of impacted lower teeth. Gauze held between tongue and jaw, retractors and mouth gag in place, and the surface of the impacted lower third molar exposed ready for extraction.

be thoroughly cleaned. The mucous membrane surfaces of the tongue, cheeks, lips, and the surfaces of the tooth crowns should be thoroughly

cleansed with alcohol and the immediate field of operation painted with iodine. Neglect or carelessness in these respects may cause great suffering to the patient or even death.

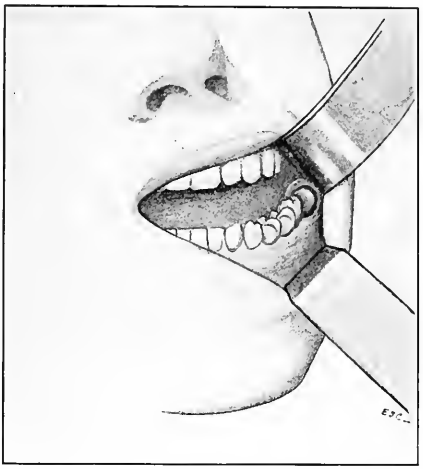


FIG. 46.—Another form of impacted lower third molar, exposed and ready for removal.

Position of the Patient.—As a safeguard against the inspiration of blood, the patient, if lying in a prone position, should have the shoulders raised sufficiently to tip the head backward. When the face is turned to one side the blood and mucus will then tend to flow into the side and posterior portion of the pharynx. In this situation quick

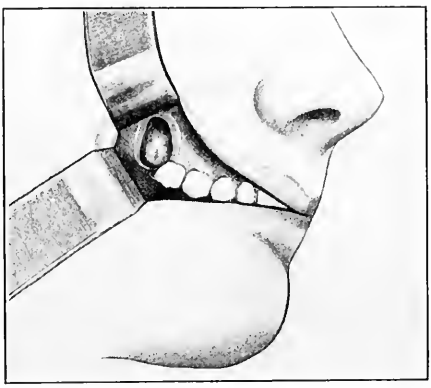


FIG. 47.—Method of exposing an impacted upper third molar for extraction.

sponging is made possible and the likelihood of passage into the trachea is decreased. In this position also a tube may be passed through the nose down to a point opposite the tracheal opening through which the anesthetic may be administered and the pharynx packed with gauze.

This procedure, while objectionable in some respects, is effective in preventing the escape of blood and mucus or the tooth in this direction.

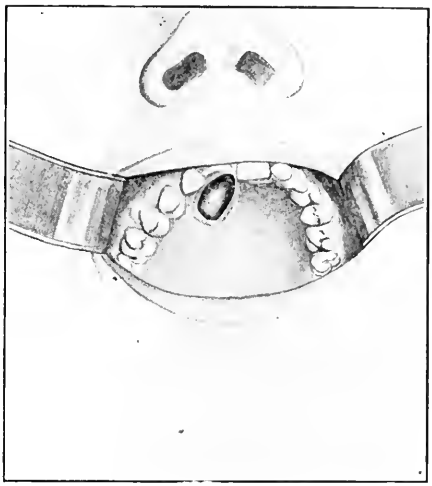


Fig. 48.—Method of exposing an impacted upper cuspid on the palate surface.

Control of the Field of Operation.—The entire field of operation may be brought into view and the operation greatly facilitated by drawing back the corner of the mouth and cheek with a retractor and

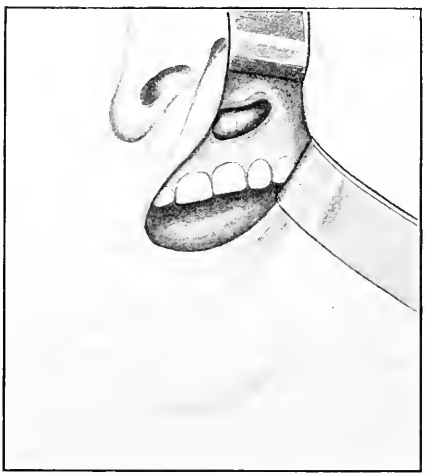


Fig. 49.—Method of exposing a malposed and impacted upper cuspid from the labial side of the jaw.

holding the tongue out of the way by a roll of gauze grasped in a forceps. The latter also serves to prevent the blood from flowing into the pharynx (Fig. 45).

Exposure of the Embedded Tooth Crown.—The tooth crown with its embedded root should be exposed (Figs. 44 to 49) sufficiently to allow it to be firmly grasped by the forceps or raised with an elevator. When this method is followed, it usually renders the use of the so-called Physick forceps unnecessary, and thus tends to avoid the danger of unnecessary fracture of the alveolar process or jaw.

This is best accomplished by the removal of the overlying and surrounding bone structure with surgical or dental engine burs. When a dental engine is used, the burs made for bone cutting or those used for finishing vulcanite plates or root canal reamers are best adapted for this purpose, because the flanges are more open and will cut fresh bone better than those intended for cutting dentin or enamel, which quickly clog and become useless.

WOUNDS OF THE MOUTH.

General Consideration of Wounds.—Definition.—A wound is a solution of the continuity of the tissues of the body caused by some external agent. Solutions of the tissues of the body resulting from disease are not classed as wounds. In surgery it is generally understood that skin or mucous membrane must be involved. In medical jurisprudence any lesion of the body resulting from external violence is so classed, thus giving much wider range in application than when the term is used in surgery.

Varieties.—Wounds are classified as follows: *Incised*, cut with a sharp instrument; *punctured*, cut with a pointed instrument; *lacerated*, torn; *contused*, bruised; *gunshot*, made by a projectile; *poisoned*, caused by toxic substances introduced into the tissues of the body, as from the bite of a venomous snake, insect, rabid dog, or from dissecting wounds.

These may be considered under one general division: *Aseptic*, free from infection by microörganisms; *septic*, infected by the microorganisms of fermentation or putrefaction.

They may be again subdivided for the purpose of description into *superficial*, affecting the skin or mucous membrane only; *deep*, involving the underlying tissues; *simple*, without complication; *complicated*, when there is any complication in addition to the wound, as from a foreign body or substance, serious infection, unusual hemorrhage, or injury to large nerves, bone, vessels, or other important structures; *surgical wound*, when made in the performance of a surgical operation; *flesh wounds*, involving only soft tissues; *subcutaneous*, beneath the skin; and *open* or *closed*.

Repair of Wounds.—Healing by Immediate Union.—When the lips of a clean incised wound are brought together at once and kept in close approximation, rapid healing occurs. In this case a microscopic examination shows slight exudation from the surface of the wound and proliferated connective-tissue cells. The epithelial continuity

is restored by proliferation of the epithelial cells. This is called healing by immediate union.

Healing by First Intention.—When apposition of the wound surface is less accurate, the amount of exudation is greater. Twenty-four hours after injury the parts are red and swollen, but soon become glazed in appearance. The process is much the same as in immediate union, except that the amount of exudation is greater and the healing process is slower. This is called healing by first intention.

Healing by Second Intention, or Healing by Granulation.—Retention by or of foreign bodies or continued exposure causes small red elevations, called granulations, to appear upon the surface of the wound within two or three days after injury. These granulations are newly formed capillaries covered by round cells, and later on giant cells occasionally appear. If the wound is infected and pus appears, the proliferated round cells gradually elongate to form new fibrous tissue, which ultimately contracts to form cicatrices or scars. Epithelial continuity is brought about by multiplication of epithelial cells at the surface of the wound.

Healing by Third Intention, or Adhesions by Granulation Surface.—Some authors use this term to signify the process which takes place when large surfaces are required to be filled in by granulations, in order to complete the healing process, as the cavities of large abscesses, and large exposed surfaces which sometimes require months to fill in. As there is no essential difference from the healing by second intention, except in degree, it seems hardly necessary to consider it as a special form of healing process.

Treatment of Wounds of the Mouth.—The steps in treatment of wounds in this, as in other regions, are as follows:

1. *Prevention or correction of septic conditions.*
2. *Control of hemorrhage.*

The order of importance of these two procedures is necessarily interchangeable, because with accident or injury to large vessels the first consideration would obviously be arrest of hemorrhage regardless of sepsis. In the absence of dangerous flow of blood, septic considerations would naturally be first.

3. *Coaptation of the Wound Surfaces to Promote Healing.*—Wounds of the mouth involving maxillary bone structures do not often permit exact approximation of the overlying soft tissues. Incisions or injuries affecting the cheeks and lips require the greatest possible care. Not only must the deeper tissues and the mucous membrane, as well as skin surfaces, be brought into direct contact to facilitate union, but reunion of divided muscles necessitates skilful adjustment to secure correct muscular action after the healing process has been completed, and to give freedom from the contraction of scar tissue, which causes deformity when the parts are at rest, and in even greater degree during muscular action.

4. *Dressings if required.*

5. *Prevention of Undue Physiological Action.*—The prevention of tension and provision for physiological rest are matters of great importance and often of considerable difficulty. Sutures and dressings intended to overcome this strain upon the wound surfaces must be of such character as to hold securely until a period of time has elapsed sufficient to enable the muscular fibers to become securely united.

6. *Drainage* is sometimes required, but rubber or glass tubes and other methods employed to prevent the collection of fluid in deep wounds of other parts of the body are, as a rule, impracticable to use in the mouth. The capillary drainage of gauze packing is the correct procedure.

Dressing.—Dressings in the buccal cavity, as dressings in other parts, should give protection against external pathogenic bacteria, permit the healing process, and prevent the collection of pus or other fluids which tend to delay the process of repair. In addition they should have antiseptic properties to combat the pyogenic and other microörganisms constantly present in the oral secretions. The danger of swallowing germicidal agents, however, necessitates a weaker strength than would otherwise be advisable. The almost unavoidable further weakening by solution with the salivary secretions renders it exceedingly difficult to find an agent capable of maintaining its own integrity under these conditions for a sufficient length of time.

The author's rule is to leave shallow cavities and open surfaces in the mouth uncovered and to depend upon frequent cleansing with mild antiseptic solutions for the prevention of serious infection and to promote granulation. In deep inaccessible or unfavorably situated cavities in bone, which of necessity cannot drain themselves properly, packing with sterile gauze wrung out in acetozone, or some antiseptic solution, such as compound tincture of benzoin, or 1 to 10,000 bichloride of mercury, and sealed with a solution of gutta-percha and chloroform, or collodion, is required. The gauze should not be allowed to remain more than twenty-four hours, because of the bacteria-laden secretions which are necessarily absorbed. Wounds upon the buccal surfaces of the lips and cheeks which permit of coaptation can be well protected by careful suturing of the mucous membrane with fine gut sutures.

In the treatment of all wounds the first consideration should be directed to the cause. Poisoned wounds of all varieties necessarily require, in addition to local treatment, an effort to prevent the introduction of the poison into the general circulation, and in this way to limit its effect. Beyond this there must still be general treatment to enable the system to overcome and throw off the effect of the poison. The bite of a dog, for example, should, if possible, be cauterized immediately. If rabies is suspected, the Pasteur treatment should be given in addition. Ordinarily the only danger from bites of animals is infection from the mouth secretions, which are sometimes highly toxic, especially if carrion has recently been eaten. The bites of

poisonous serpents are more apt to occur at the extremities, and may sometimes be controlled by ligatures tied above, to close the portals of the general circulation. Free blood-letting in wounds of this character and the removal of a considerable portion of tissue in the immediate vicinity of the wound, with suction to draw out the poison, are sometimes advantageous methods of protection against the general poisonous effect. Hypodermic injections of strychnin and antitoxin prepared in the usual manner from the poison of these serpents are believed to be efficacious. General symptoms are intense localized irritation, followed by marked swelling, usually accompanied, if progress be unchecked, with marked symptoms of nausea, vomiting, rapid or feeble pulse, mental disturbance, and death.

In the one case of a rattlesnake bite that has come under the author's observation, the arm of the hand that was bitten swelled to several times its natural size and became quite black. There was marked spasmodic muscular twitching over the whole body, almost to the point of convulsions, and delirium which lasted several hours, after which there was slow recovery.

Wounds received in making dissections lead to septicemia, which will be considered under that heading. In gunshot wounds and accidental injuries received from fireworks there is marked tendency to tetanus. Unless the bullet be favorably situated for removal, or in contact with some vital part which makes its immediate extraction imperative, it is not well to probe too much in an effort to locate it. Good care should be used in thoroughly cleansing a wound made by a projectile, whether it be a bullet or some other substance driven into the tissues of the body by an explosive force, because there is always the danger of infection from the skin surfaces, or from particles of clothing, fractured pieces of bone, or teeth driven into the wound. Aside from this consideration the care is practically like that of any other traumatic lesion.

All experiences in the treatment of wounds of many kinds since the beginning of the war in 1914, and particularly the vast number of mouth, jaw, and face injuries from projectiles of every description complicated as these have been by infections, tetanus, gas bacilli, and other complications which have been favored by the situations and conditions of warfare render it necessary to give more detailed consideration to the treatment of wounds of the mouth in Chapter XIV, devoted to this subject.

Treatment of Hemorrhage from Wounds of the Mouth.—There are some special considerations pertaining to the treatment of hemorrhage following operations upon the tissues of the mouth and jaws, which, notwithstanding the fact that they are necessarily frequently referred to in the description of surgical operative procedures, require distinct recognition in this connection.

1. Preceding operations of serious character, the coagulation time of the blood should be taken.

2. As a matter of postoperative precaution during the period of unconsciousness following the administration of a general anesthetic, the patient's head should be kept turned upon one side, so that the blood, if any, will flow out of the mouth, where it will be observed and not be likely to be inspired.

3. When wounds of the mouth give evidence of excessive flow of blood from a vessel, or of capillary oozing with tendency to persist, whether the operation that has been performed be the extraction of a tooth or other minor procedure, or a major operation involving division of tissue over a large area, the bleeding should, if possible, be checked immediately at the time of operation. Too often dentists or physicians and surgeons are inclined to underestimate the serious possibilities of the flow of blood from these slight wounds. Patients are allowed to leave the operating room or even go home with blood still flowing in more or less considerable quantity, the operator carelessly trusting to the cessation of hemorrhage in natural course, as he has usually known it to occur. Sometimes such hemorrhages are allowed to become matters of vital menace before hemostatic measures are instituted. It is sometimes difficult to pick up and ligate small vessels in unfavorable situations in the mouth, but it is an exceedingly simple procedure to carry a good suture in a small curved needle around the point of hemorrhage and to tie it with sufficient pressure to check the flow of blood. The small portion of tissue, other than the vessel itself, which may be included in the ligature is not important. Dentists, particularly would save themselves and their patients trouble by the habitual use of this simple procedure. All incisions in the mouth in surgical operations should be made so far as practicable of such form and in such situations that blood may be checked either by ligation or packing of the wound. This can nearly always be accomplished, and the principal dangers of postoperative hemorrhage thus avoided. Ligation or compression of the external carotid is an important emergency procedure to prevent uncontrollable or dangerous loss of blood in certain grave operations, and compression of the vessels of the extremities by rubber bands at the shoulders and hips is one of the measures sometimes adopted to reduce the activity of blood flow in mouth and head operations.

The author has but little faith in the use of local astringent applications, and believes it is safe to assume that hemorrhage is under control only when it is positively checked by ligature, packing, or natural coagulation and vascular contraction. The local application of adrenalin directly or as a spray is useful in slight capillary hemorrhage.

When a tooth has been extracted, it is usually practicable to pack the socket with gauze, but sometimes the gushing of blood, even under these circumstances, is so great as to force the packing out. In these cases a packing much larger than is necessary to fill the tooth socket must be used, and the surplus packing arranged above the

alveolar ridge in such manner that the jaws can be bound together and sufficient pressure exerted to overcome that of the blood. Cases have been reported of dangerous hemorrhage where several teeth have been simultaneously extracted, particularly when the outlines of the tooth sockets have been destroyed by the removal of portions of the surrounding alveolar processes incident to the extraction of badly decayed roots; and in these cases it is often impossible to locate a particular vessel as being the cause of the flow of blood, and packing, except in a general way, is also impracticable.

Under these circumstances a simple method sometimes resorted to by dentists where strictly surgical methods have failed is to fill an impression cup with plaster of Paris, placing this in the mouth as if to take an impression, but allowing it to remain *in situ* and binding the jaws firmly against it. When it becomes evident that a patient's blood does not have the normal property of coagulation, whether this be due to hemophilia or to some temporary pathological state affecting the blood, treatment must be instituted to arrest the hemorrhage. (For further description see page 40.)

CHAPTER III.

INFECTIOUS DISEASES.

A BETTER understanding of toxicogenic and pathogenic microorganisms and the chemical substances which they elaborate, as well as the laws governing the action of body tissues and organs when subject to morbid conditions, has led to the belief that many terms in their strict sense are misleading or incompatible with our present knowledge of bacteriology and pathology. It has also shown the need of avoiding expressions which imply distinction between forms of disease that are rarely applicable to actual clinical conditions. The wide differences of opinion expressed by eminent writers on pathology, surgery, physical diagnosis, and clinical medicine, with regard to the application and meaning of the terms sapremia, septicemia, toxemia, septic intoxication, pyemia, etc., warrants a few simple definitions even at the risk of appearing to be too elementary, in order that the author's conception of correct classification may be clearly understood.

Definitions and Nomenclature.—*Septic intoxication* is the absorption of toxic products with resulting general symptoms of disease without entrance of the infecting microbe into the blood current (Keen).

Infection is a condition produced by the entrance and growth within the body of pyogenic microörganisms (Pearce, Osler).

Poisons.—This term, when given broad application, signifies any substance injected or developed within the body which causes disease (Smith, Keen).

Distinction is made between *true toxin*, a special ferment characteristic of certain bacteria, and *protein poison*, the intracellular toxin that is caused by bacterial destruction when the sensitized body cells, by the special ferment thus formed, break down the bacterial cells. Protein poison is produced by destruction of bacterial proteins.

Toxemia.—A condition of the blood in which it contains poisonous products, either those produced by the body cells and not properly eliminated or those due to the growth of microörganisms (Gould).

Sapremia (*Putrid Intoxication*).—According to derivation and older application, sapremia was intended to describe a result of the bacteria of putrefaction. Among recent writers, both Johnston and Brewer accept its meaning in that light. Johnston says, "It is a condition caused by the absorption into the system of the saprophytic bacteria," but admits that poison solely due to the saprophytes or bacteria of putrefaction without toxemia from pus microörganisms does not often occur even with gangrenous conditions. Stengel expresses

the more general sense in which sapremia has become understood when he says it is a condition that results from the absorption into the general circulation of toxic products from local suppurative foci.

Septicemia is the descriptive term applied when the infecting bacterium itself enters the blood current without giving rise to any secondary collection of pus. Anders defines septicemia as "A disease due to the introduction into the system of the products of putrefaction (sapremia) or to microbic invasion of the blood and tissues (true septicemia), with or without the presence of a local seat of infection." *Pyemia* signifies that microörganisms have been carried through the circulatory channels and that infective emboli have formed new foci of inflammation with resulting metastatic abscess. "Septicemia plus metastatic abscesses."

Pearce[1] calls attention to the confused state of the nomenclature of these affections, and suggests the use of the word "toxemia," the meaning of which he would circumscribe as follows: "Under the term may be included all intoxications due to the absorption of bacterial poisons. For convenience of description two subdivisions may be made: (1) The toxemias associated with affections demanding surgical intervention—the so-called 'sapremia;' and (2) those of the acute infectious diseases, such as diphtheria, typhoid fever, and pneumonia."

Smith specifically urges the abolishment of the term sapremia and other indefinite or inaccurate expressions, and also brings forward the word toxemia as a suitable substitute; but he desires to limit it even more strictly than Pearce, and claims that it should only be intended to "apply to the diseases in which one or more poisons are present in the blood which are not of parasitic production, while septicemia should be applied to diseases which present poisons in the blood that are of parasitic origin, the parasite itself being in the blood."[2]

Bacteriemia (the presence of schizomycetes in the blood) has come to be quite generally used in the effort to avoid technical confusion.

Notwithstanding these differences of opinion among authorities, when judged from a surgical point of view the essential distinction resolves itself into the simple question as to whether the cause of the symptoms of disease is non-septic or septic in character. It appears to the author, after a careful review of the opinions of the writers whose definitions have been given, and many others that could not be included, that *toxemia*, according to the definition given by Pearce, is in some degree a better and less confusing term than *sapremia*, which has been so variously applied. According to this, our division of the subject would then be toxemia, septicemia, and pyemia. That these conditions may be coincident or may follow each other without the possibility of a distinct line of demarcation in many cases is undoubtedly true. It is also a notable fact that efforts to clarify the meaning

[1] Osler: Modern Medicine, 2d ed., vol. i, p. 550.
[2] Alfred Smith, in Keen's Surgery, vol. i.

of these terms in general use by coining new words or attempting to outline absolute limitations for their use tends to make the matter of proper classification more instead of less difficult.

PYREXIA (FEVER).

Hyperthermia, or elevation of bodily temperature above normal, is one of the expressions of many pathological conditions.

Direct exposure to heat has been known to cause hyperthermia in animals and in small degree in man, but the heat-regulating adjustment is usually so effective that the change from this cause alone is slight in individuals in good health. Excessive heat may lead to nervous or other disarrangement of bodily conditions, whereby toxic substances may be produced. It is in this way that the heat centers of the brain become affected in sunstroke.

It is important to remember, in the treatment of fever, that causes other than bacteria and their products may incite increase of bodily temperature, and again that fever is sometimes beneficial in favoring bacterial conditions and then becomes one of the natural efforts to overcome the disease.

Drugs which reduce the temperature by reducing the heart's action are therefore to be avoided, and therapeutic efforts should always be directed to the relief of the cause rather than this symptom.

Hysteria and nervous diseases of such character as to affect these centers directly have also been known to cause fever. But, as a general rule, fever is caused by toxic substances. These may be from bacteria, or products of the growth of microörganisms, albuminous bodies of this nature, or those developed quite outside of bacterial action.[1]

The irritability of the heat-regulating center (presumably in the basal ganglia because a proper heat regulation cannot be maintained unless certain parts of the midbrain are intact) is particularly susceptible to chemical action and infectious processes. Friedberger found that small specific proteid caused fever in animals sensitized by that proteid, while collapse with subnormal temperature and even death resulted from the injection of larger amounts. He holds that anaphylatoxin is the uniform cause of infectious fevers by stimulation of the heat-regulating center.

Aseptic Fever.—Aseptic wound fever, ferment fever (von Bergmann), resorption fever (Billroth), after fever, traumatic fever.

Etiology.—This form of fever is now believed to be chiefly if not altogether due to the absorption of nucleins and albumoses, substances occurring in extravasated blood. This has been proved by the introduction of these substances into the circulation of animals. It was formerly looked upon as a result of absorption of the fibrin ferment formed in extravasated blood. That other factors also enter into the

[1] Beilfield: The Basis of Symptoms, p. 404.

causation of fever following surgical operations under aseptic conditions is shown by the well-known fact that rise in temperature may be but slight after severe operations and higher when the operation is in no respect severe. The loss of large quantities of blood, the length of time of operation, imperfect hemostasis, bruising and strangulation of tissue, an undue amount of general anesthetic, operation in the region of important nerves, and other factors which govern the degree of shock are all important elements in the increase of temperature after surgical operative procedures. Fright alone may so act upon the heat centers as to cause fever. Just where the line of demarcation should be drawn in a dogmatic way, distinguishing a single element as responsible for aseptic wound fever, is uncertain.

Septic Fever.—A fever caused by one or more of the forms of acute general sepsis, such as toxemia, septicemia, pyemia, and allied conditions.

Etiology.—The bacteria generally gain entrance through wounds or the mucous membrane of the alimentary, respiratory, or genito-urinary tracts, or the infection may occur in the course of pneumonia, erysipelas, puerperal fever, typhoid fever, and other similar diseases.

Occasionally it is impossible to determine the point of entrance of the microörganisms, and such an infection is described as cryptogenetic.

Since the bacteria of septicemia are identical with those of pyemia, it is difficult to understand why they form foci of inflammation in some cases and not in others.

The organisms most frequently responsible for septicemia in surgical cases are streptococci, staphylococcus, the pneumococcus, Bacillus coli communis, gonococcus, Bacillus pyocyaneus, Bacillus aërogenes capsulatus, and Bacillus anthracis.

Symptoms.—There are certain general symptoms which are typical of cases of acute general sepsis. Variation from these and the degree of severity largely determine clinical diagnosis of the type.

In *toxemia* there is usually a chill, although in some cases this symptom is not distinctly marked. The succeeding fever may be only a slight rise in temperature, varying from 100° to 101° or 102° F., with a tendency to become higher in individuals of poor resistance or under other unfavorable conditions. The rapidity of the heart's action is increased, there is usually a feeling of general malaise, headache, disturbance of the digestive tract, and nervous symptoms which vary from slight restlessness to serious manifestations or delirium. The *septicemic type* may be ushered in by symptoms of intoxication, which may progress slowly or rapidly into those of the more serious form of sepsis, or there may be an initial chill of great severity with rapid progress to a fever of 102° to 104° F., or even higher. The pulse becomes rapid and irregular, and there is great prostration with marked loss of flesh, due in part to the rapid wasting under high fever and in a measure to nausea, vomiting, diarrhea, albuminuria, and uremic symptoms that are quite commonly present. There is usually delirium, which, when

conditions are beyond control, is rapidly succeeded by coma and death. *Pyemia* is sometimes preceded by symptoms of intoxication and septicemia, which in due time may be followed by the metastatic abscesses which mark the pyemic type. Under these circumstances there is a tendency toward *chronic pyemia*, which is evidenced by the breaking out of abscesses in various parts of the body. These abscesses sometimes disappear and reappear during a long period of time without marked acute symptoms, such as are generally incident to abscess formation, or *acute pyemia* may result more rapidly, with a series of chills, indicating new foci of inflammation. These symptoms are quickly followed by high fever, approximately 103° to 105° F.; profuse sweats; sallow skin; disorders of the intestinal tract, which may be indicated by inability of the stomach to retain food, diarrhea, or constipation; and other symptoms that from time to time mark the effect of abscesses of internal organs, especially the lungs, liver, kidneys, brain, and joints. Ulcerative endocarditis is also likely to occur with petechial hemorrhages.

Treatment.—In all forms of general sepsis the first essential is to find and correct the source of the infection. If the focus be an abscess, and is so situated as to make opening and evacuation of pus possible, that should be done, proper drainage established, and suitable antiseptics applied. The amputation of a gangrenous extremity, the removal of diseased bone or of an organ that cannot safely be retained, is required when such condition exists. In a general way the treatment of all such cases requires therapeutic measures designed to assist the elimination of the poison and reëstablish normal physiological processes. To this end saline purgatives, calomel, and the drinking of large quantities of water are indicated. Copious rectal irrigations are sometimes very beneficial, especially high bowel flushing with normal salt solution.

Hypodermoclysis.—In extreme cases the saline must be given by hypodermoclysis or even by *intravenous infusions* in order to obtain a more direct effect. The author believes, as the technic becomes simplified and conditions governing hemolysis better understood, that *the direct or the indirect transfusion of blood* will be more and more resorted to for overcoming the toxic effect of septicemia and kindred affections of the blood.

Plondke[1] recommends the old method of venesection, combined with the newer one of intravenous infusion of normal salt solution for the purpose of rapid elimination of the toxins and the neutralization by dilution or otherwise of those which remain. He reports a number of cases, in all of which there was an immediate abatement of danger symptoms, followed by prompt recovery. He gave no other treatment except a dose of salts every morning and a hot vapor bath daily for a week, as a matter of precaution. Figs. 50 to 53 illustrate the technic of his method, which is described as follows:

[1] Jour. Am. Med. Assn., January 14, 1911, pp. 115 and 116.

"Any prominent superficial vein, preferably the median basilic on the anterior surface of the elbow, is selected. Constriction is made above by applying a bandage just tight enough to cause congestion sufficient to make the vein prominent. The parts are carefully cleansed and under local or general anesthesia an incision from 1 to $1\frac{1}{2}$ inches in length is made over the long axis of the vein, which is exposed by carefully dissecting it loose from the contiguous tissue. A double ligature of No. 1 or single 0 catgut is then carried under the vein by an aneurysm needle, tissue forceps, or other suitable instrument (Fig. 50, *a*), and the two ligatures tied around the vein with a single knot at either end of the incision, from $\frac{1}{2}$ to $\frac{3}{4}$ inch apart (Fig. 51, *a*, *a*). The

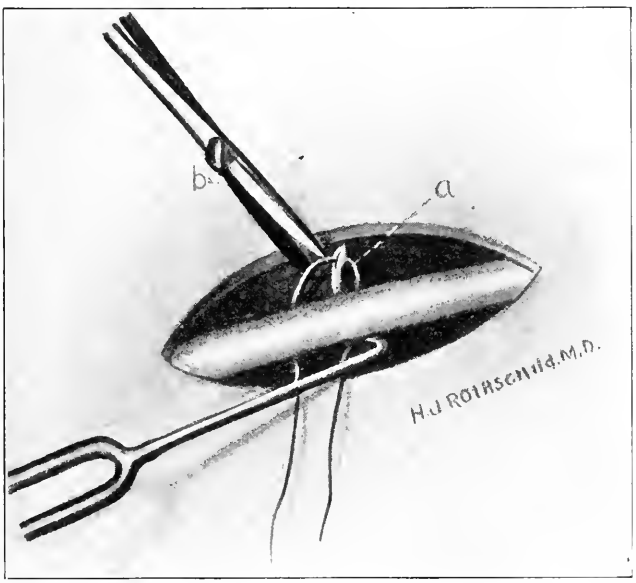


Fig. 50.—Plondke's method of combined venesection and intravenous transfusion of normal saline. Passing the ligature.

external surface of the vein is then grasped with a small rat-toothed tissue forceps midway between the two ligatures (Fig. 51, *b*) and divided at this point (Fig. 51, *c*) transversely upward (or downward, as desired) about half-way through its circumference. The end of a thin-walled glass cannula, with the largest diameter that will be admitted, is then inserted downward into the distal end of the opening in the vein (Fig. 52, *a*); traction is then made on one end of the ligature (Fig. 52, *b*) when the single knot readily loosens, allowing the cannula to pass through the loop (Fig. 53, *a*); the ligature is again tied, this time around the vein containing the end of the cannula (Fig. 53, *b*) (it is important that the lumen of the cannula is not too small, otherwise the blood will coagulate and refuse to flow); the constriction is then

removed and another cannula, which may be of smaller diameter, attached to a rubber tube coming from a receptacle containing a normal salt solution, is inserted (with the solution slowly escaping from the

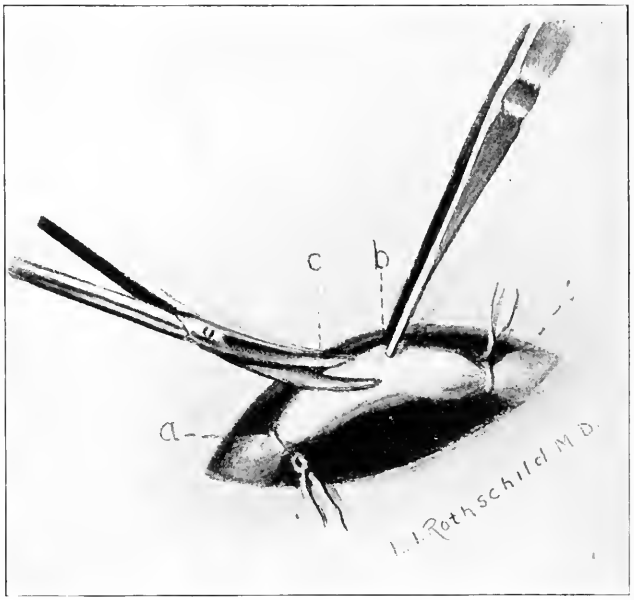


FIG. 51.—Plondke's method of combined venesection and intravenous transfusion of normal saline. Ligature tied. Cutting vessel.

tube) upward into the other (proximal) end of the opening in the vein (Fig. 53, *c*) in exactly the same manner in which the first tube was

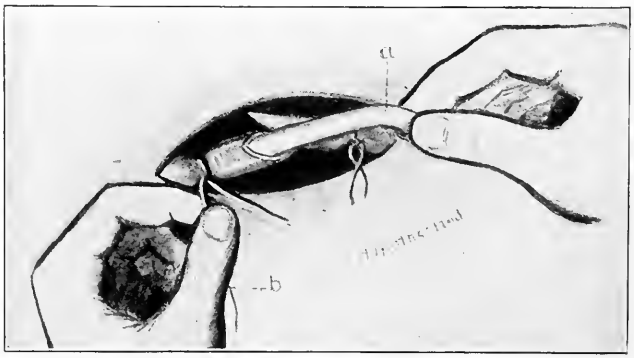


FIG. 52.—Insertion of glass cannula into the distal end of the vein.

introduced. When the desired amount of blood has escaped and a sufficient quantity of salt solution introduced the tubes are carefully

withdrawn, while the assistant securely tightens the knot, obliterating the vein. The skin wound may be closed by any suture desired."

Collargol (Credé's preparation of colloidal silver), 2 to 10 c.c. of a 2 per cent. solution of 500 to 1000 c.c. of a 0.1 per cent. solution given by intravenous injection, is strongly recommended by some surgeons for its non-irritating and strongly bactericidal properties.

Vaccine Therapy.—Much study, experimentation, and clinical employment of bacteriolytic sera have taken place during recent years, with, as might be expected, much diversity of opinion as to the result. That treatment of this nature will bear an important part in the control of infectious diseases there is no good reason to doubt. At its present stage of development, however, the author feels that it would be unsafe to do more than present the following excerpts from recent literature as evidence of known facts and experiences.

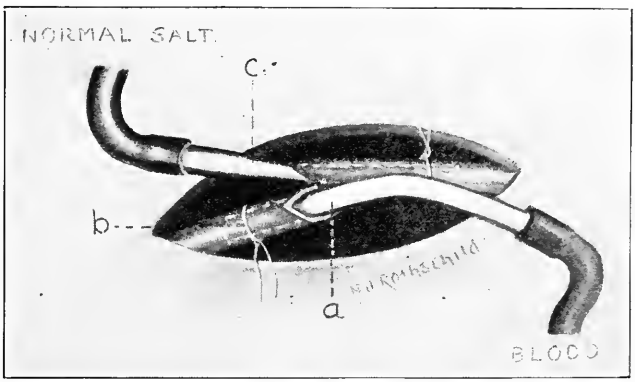


FIG. 53.—Plondke's method of combined venesection and intravenous infusion. Glass cannulas inserted; one cannula attached to a rubber tube from the receptacle containing saline solution; the other allows control of the escaping blood.

All serious cases of septicemia are treated by Hagermann by injections of antistreptococcus serum (10 to 20 c.c. in several doses). By repeated examinations of the blood and pus, he is convinced that the serum acts on all streptococci, but has no specific action on any one variety. Fromme stated that the most virulent streptococci give rise to most hemolysis; the determination of this takes thirty-five hours.

Loberson has obtained 50 cures in septicemia out of 80 cases by the use of antistreptococcus serum.

Thomas arrives at the following conclusions as a result of three years' experience in bacterial immunization.[1]

"In all, 50 distinct diseases were treated. Both by desire and virtue of circumstances, the time-honored measures of proved worth were never abolished from treatment during the periods of bacterial

[1] Jour. Am. Med. Assn., January 29, 1910.

inoculations, because he has always considered bacterin therapy as an accessory, not as a specific agent. It was never intended to be, nor will it ever be, a 'cure-all,' but should be regarded as an aid to assist nature, in properly selected cases, to combat infection by fortifying the organism through the production of immunization by antibodies. In many instances it has been a difficult matter to decide how much of the cure should be attributed to the usual method of treatment and how much to bacterial immunization. Nevertheless, in certain classes of cases the results have been consistently so striking that the value of inoculation by dead bacteria is undeniable.

"Autogenous bacterins are always to be preferred over the stock preparations, and success or failure frequently depends on this fact. Although the duration of the period of greatest potency of bacterins is undetermined, the best results have been obtained when the pus has been recultured and a fresh bacterin prepared every two to four weeks.

"It is believed that the best effects, therapeutically, particularly in chronic cases, occur when the quantity is slowly and cautiously increased, thereby, as has been thoroughly demonstrated in tuberculin therapy, avoiding hypersusceptibility or anaphylaxis."

TETANUS (LOCKJAW).

Tetanus is an infectious disease due to the tetanus bacillus. It is characterized by tonic spasms of the muscles which are first manifested in the jaws and neck and progress until the muscles of the back and extremities are also involved.

Etiology.—The tetanus bacillus was first isolated by Kitasato in 1889, but as early as 1884 Carle and Rattone had proved the infectious character of the disease by inoculation of animals with material from the wounds of afflicted individuals.

Earth, especially garden soil, the dust of old barns, outhouses, and manure heaps, is the natural habitat of the organism.

It is anaërobic, and may develop spores after twenty-four hours. In a dry state the spores may retain their virulence for long periods of time. They can withstand boiling for five minutes, and offer considerable resistance to antiseptics.

Cases of idiopathic tetanus have been reported, and a form of the disease affecting newborn infants (trismus nascentium) occurs somewhat frequently, but, nevertheless, it is believed that tetanus can only be induced by entrance of the organism through some form of inoculation. Injuries causing wounds of the skin or mucous membrane surfaces are usually responsible for the infection.

The frequency of tetanus after accidental injury from firearms, fireworks, and powder explosions has led the *Journal of the American Medical Association* to prepare an annual list showing the extent of such Fourth-of-July injuries, with a view to their prevention. This record, as shown by the following table, gives a trustworthy indication of this etiological feature:

CAUSES OF TETANUS CASES.

Year.	Blank cartridge.	Giant cracker.	Cannon.	Firearm.	Powder etc.	Total.
1903	363	17	5	3	27	415
1904	74	18	5	1	7	105
1905	65	17	4	5	13	104
1906	54	17	1	7	10	89
1907	52	8	6	4	3	73
1908	58	5	4	3	6	76
1909	130	9	1	4	6	150
1910	64	2	..	5	1	72

Of the 72 cases in 1910, 67 (93.1 per cent.) ended fatally as compared with 84 per cent. in 1909, 72 per cent. in 1908, 85 per cent. in 1907, and 84 per cent. in 1906."[1]

Symptoms.—The incubation period varies, but usually occupies ten to fifteen days. The forms in which the disease appears are *acute, chronic* and *cephalic.*

Acute tetanus is indicated by sudden onset of the symptoms of malaise, headache, chills, stiffness of the neck, and tightness of the jaws. Lockjaw, or tonic spasm of the masseter muscles, follows, and the contraction of the muscles of the eyebrows and of the angles of the mouth gives the appearance known as risus sardonicus. As the muscles of the body begin to be affected the back becomes curved and the body rests upon head and heels (opisthotonos); pleurosthotonos, or drawing of the body to one side, is less frequent; emprosthotonos, forward bending, occurs very rarely.

The clinical picture is one of great distress, and, once seen, never to be forgotten. Paroxysms may succeed each other rapidly or slowly, and the length of their continuance be variable; dyspnea and cyanosis are usually quite marked; the pain is sometimes intense, and the fact that the mind remains clear adds in untold measure to the horrible agony of suffering. Fever may be slight or it may reach a high temperature, 105° F. or more. Failure of the heart, or asphyxia due to fixation of the respiratory muscles, may cause death, or it may occur from exhaustion within a few hours or after several days (approximately ten).

In one case that came under the writer's notice, that of a boy who several days before had slept all night in a barn and had his fingers so badly frozen that they required amputation, death occurred within twenty-four hours after the operation, and less than that time after the first convulsive symptoms were noticed.

Chronic Tetanus.—Chronic tetanus exhibits symptoms much the same as in acute cases, but with less severity. In such cases the disease sometimes continues for weeks, with gradual tendency toward decrease in the frequency of the spasmodic attacks, until finally recovery ensues.

[1] Jour. Am. Med. Assn., September 3, 1910.

Cephalic Tetanus (*Kopf Tetanus*).—This form occurs after injuries in the region of the distribution of the twelve cranial nerves. It is accompanied by paralysis of one or more of the motor nerves, especially the facial, and occasionally by sensory disturbance of the trigeminal nerve. The tendency is to localization of the tetanic spasms in the lower jaw and neck and in the muscles concerned in deglutition and respiration.

Diagnosis.—In well-developed cases diagnosis is ordinarily comparatively simple. In tetany the symptoms of muscular contraction are chiefly evident in the extremities, and since it is a neurosis associated with hysteria or the toxins of typhoid and similar fevers, there is absence of an abrasion or wound to account for the infection, and a clinical history which usually serves to complete the diagnosis. In strychnin poisoning involvement of the jaw muscles appears late, if at all, instead of being an early and constant symptom, as in tetanus, and muscular relaxation between paroxysms is complete.

In the cephalic type, as the symptoms are chiefly manifested by spasmodic contraction of the lower jaw, a number of affections require differentiation, especially in cases of tooth impaction or after the extraction of teeth. In one of the author's cases of chronic tetanus the diagnosis was difficult, owing to the fact that the tetanus bacillus had gained an entrance through an abrasion of the cheek by jagged edges of diseased roots of teeth, while the symptoms readily might have indicated infection from abscesses at the apical ends of these roots. It is well known that direct irritation of the inferior dental branch of the fifth nerve may excite motor disturbance and cause spasmodic contraction of the muscles of mastication. Swelling in the region of the third molar or around the temporomaxillary articulation may interfere with jaw movement, and in nervous patients excites symptoms which might easily be confused with the premonitory symptoms of tetanus. Recognition of the true cause and the absence of more general symptoms makes the diagnosis complete.

Prognosis.—The mortality is variously estimated at from 80 to 90 per cent. before the introduction of modern methods of treatment, and approximately 40 per cent. at the present time. There seems to be a fatal tendency in cases in which the period of incubation is short or less than the usual ten days; in those, however, in which the onset is slow, and which more nearly approach the chronic form, the prognosis is much more favorable.

Treatment.—Death in tetanus occurs primarily as a result of the direct action of the toxin and because of the exhausting effects of the convulsions; contributing factors are the starvation, loss of sleep, and the horror suffered by the conscious patient. Treatment must include the following:

1. *The bacteria at the seat of infection* should be destroyed to prevent further production and absorption of the toxins. To this end local disinfection and removal of diseased tissue must be prompt and as

complete as possible. The agents chiefly used are bichloride of mercury, a 2.5 per cent. solution of carbolic acid, creosote, or other similar germicides. Thorough cleansing of the wound surface whenever possible should be supplemented by actual cauterization and swabbing with tincture of iodin or nitrate of silver. Balsam of Peru is recommended by Hessert[1] as possessing "some antagonistic action on the tetanus toxin."

2. The toxins already absorbed from the primary lesions should be eliminated from the body. Cathartics, diuretics, and sudorifics are used as aids.

3. The circulating toxin should be neutralized, since it is at present impossible to reach the toxin already in combination with the nerve cells and to immunize the body after infection has taken place. The antitetanic serum is used for this purpose. Reports as to its value differ as its effectiveness is influenced by many factors, but notwithstanding, it is generally accepted as the most promising method of treatment.

4. Every effort should be made to overcome the symptoms by inducing muscular relaxation and preventing the exhaustion of the tetanic spasms, thus conserving the patient's strength to counteract the disease. The bromides and opium have been used more or less successfully for this purpose.

Spinal injections of magnesium sulphate tend to eliminate the spasms, and seem to have helped many patients to recovery who might have died under serum treatment alone. McPhedran[2] recommends the use of a 25 per cent. sterilized solution of magnesium sulphate in distilled water, and injects it into the spinal canal between the third and fourth lumbar vertebræ without preliminary removal of spinal fluid. He reports 11 cases, with 5 recoveries.

Recently the use of chloretone, introduced per rectum in 30-grain doses with 2 ounces of olive oil, has been highly recommended.[3]

Chloretone is said to markedly decrease the rigidity within a definite period after administration. Thus by relieving the trismus it enables the patient to take nourishment and retain strength.

Hutchins reports 5 cases in which chloretone was used in connection with antitoxic serum injections. Recovery took place in all except 1 case, in which death ensued from peritonitis following an intestinal perforation.

Large doses of antitoxin seem to be required in successful treatment of tetanus. Charles H. Lemon, of Milwaukee, reports an interesting case of a boy, aged twelve years, who stepped on a chicken-bone in a barnyard and was given 3000-unit doses every three hours. In his case a total of 42,000 units were given. The boy recovered. Another case that he treated in association with Caffrey has been reported and

[1] Surg., Gynec. and Obst., 1909.
[2] Canadian Jour. Med. and Surg., June, 1909.
[3] Surg., Gynec. and Obst., 1909.

published in the *Journal of the American Medical Association*, November 5, 1910, as follows:

"A case was successfully treated by Dr. A. J. Caffrey with large quantities of antitoxin. The patient was a youth, aged eighteen years, and symptoms appeared about twelve days after running a splinter in the big toe while barefoot. In all, 112,500 units were administered. The temperature never ran higher than 103° F. A rash, not unlike that of scarlatina, with intense pruritus appeared. Morphin was resorted to with good effect, but to Caffrey it appeared the antitoxin effected the cure, and without it he believes the patient would have died September 9, as on that day the dyspnea was intense and the patient became cyanosed, but after each dose he regained his color and got the needed rest."

Prophylaxis.—Much attention is now being given to the prophylactic injection of serum in suspicious cases. Murphy[1] states that "The public should be taught that all punctured wounds of soiled hands, feet, or face should have a prophylactic dose of antitetanus serum. Every patient with a lacerated or contused wound brought to Mercy Hospital receives an injection of serum in the admission dressing room. We have not had a single case of tetanus following this treatment."

In view of the record of the *Journal of the American Medical Association*, it would seem that the victims of injuries from fire-works or firearms must be given promptly a prophylactic dose of antitoxic serum as a precautionary measure.

For further reference to this affection see Chapter XIV.

TUBERCULOSIS.

Tuberculosis is an infectious disease caused by the Bacillus tuberculosis. The characteristic tubercles may or may not be present.

Etiology.—The sputum of consumptives is the chief medium in the transmission of tubercle bacilli. An advanced consumptive expectorates several billions of bacilli in a day. The bacilli dry, the particles separate, and they are carried upon currents of air and thus form an almost unlimited infectious influence.

Sputum accidentally forced out in coughing or sneezing, the careless placing of sputum-laden handkerchiefs in pockets, kissing, sputum-soiled hands, infected articles of clothing, and similar means of conveying the bacilli, that can only be prevented by the exercise of scrupulous care, are in the vast majority of cases responsible for the transference of the infection.

Flies are now recognized as active agents in the spread of tubercle bacilli. Dr. Ch. Andre[2] has found that after feeding on tuberculous sputum they evacuate bacilli after six hours, and some may be found

[1] Practical Medicine Series, 1911; General Surgery, ii, 140.
[2] Krebs: Tuberculosis, p. 49.

in feces as long as five or six days afterward. Food thus polluted by flies will affect guinea-pigs. Foodstuffs may also be polluted with bacilli adhering to the feet of flies after contact with sputum.

Bovine tubercle bacilli undoubtedly play a more or less important part in spreading the disease. Koch denied this in 1901, but Ravenel has produced the disease in cattle with the bacillus from human sources, and reports cases of men infected accidentally from animals, and maintains that "human and bovine tuberculosis are but slightly different manifestations of one and the same disease, and that they are intercommunicable."

Tubercular lesions in monkeys and other animals are in many respects unlike those of man. The tubercle bacilli in fowls, the so-called *avian tubercle bacillus*, for instance, is more club-shaped and branching, and shows distinct differences with regard to culture media and toleration of temperature.

Fish, notably carp, that are supposed to have come in contact with human sputum in the water in which they were raised also show distinct differences in temperature toleration.

The consensus of opinion, however, is that all of these are different forms of the same disease, and due to practically the same bacillus.

Portals of Entrance.—The four distinct modes by which the tubercle bacilli gain entrance to the body are: (1) Inhalation; (2) through the digestive tract by means of food containing the bacilli, and otherwise; (3) direct inoculation through the skin or mucous membrane surface; and (4) intra-uterine infection through the placental circulation.

Pulmonary entrance through the respiratory tract has long been believed to be by far the most frequent mode of infection, but experimentation and clinical observations are causing a much increased realization of the importance of the *digestive tract* in this regard.

Owing to the bacteria-laden sputum, the *oral cavity* in phthisical patients is constantly filled with tubercle bacilli, and it has been proved over and over again by Cooke, Latham, and many bacteriologists that these bacilli are frequently found in the mouths of individuals who have no sign of tuberculosis. It is also true that carious teeth, diseased tooth pulps, and gums frequently contain tubercle bacilli. But in spite of all, primary infection in this region is comparatively rare.

The tonsils appear to bear an important part in the causation of the disease, and their crypts are frequently the sites of primary infection.

Intestinal tuberculosis, according to Osler,[1] occurs in about 30 per cent. of all cases. How many of these were primary it is difficult to say. The pharynx, esophagus, and stomach are rarely primarily involved. In children under fifteen years the lymph nodes are the most frequent locations of primary tuberculosis.

Direct inoculation through abrasions or wounds occurs frequently.

[1] Krebs: Tuberculosis, p. 38.

Heredity.—Experimentation has proved that tuberculosis can be produced through the semen and through the placental circulation, and therefore hereditary tuberculosis can no longer be absolutely denied as it has been in the past. These cases, however, deserve slight consideration, because of their rarity in comparison with cases in which, perhaps, an hereditary predisposition gives increased susceptibility to infection by the tubercle bacillus, and in comparison with cases affected through the usual channels.

Pathology.—*Miliary tubercles* are small, grayish-yellow or white tubercular nodules, usually varying from 1 mm. in diameter to the size of buckshot. Many of them are undoubtedly microscopic. They appear in the course of acute miliary tuberculosis, and may be found in great numbers throughout the principal internal organs, membranes of the brain, bone marrow, etc. The formations are not necessarily tubercular, as such nodules are sometimes found in other diseases.

The inflammatory lesions occur in the tissue between and surrounding tubercles, although such inflammatory processes sometimes develop without recognizable tubercle formation. Caseous change takes place in the form of areas having a dull, opaque, lusterless, grayish-white appearance. Liquefaction occurs in the necrotic tissue thus formed, with resulting characteristic cavities. In tuberculosis of bone, cavities which may be quite extensive are formed. These are found to be filled with liquefied, caseous material, and are known as cold abscesses. The tendency to encapsulation of tubercular foci by the formation of fibrous tissue is an important feature of the disease and one upon which the possibility of cure is largely dependent.

Tubercular lesions that have become encapsulated may remain inactive, or at least without general invasion of the tissues, for long periods of time, and yet through loss of integrity of the surrounding fibrous tissue capsule, by infection or otherwise, the disease may become general.

Undoubtedly through the self-limiting influence of tuberculosis many individuals who have been believed to be free from the infection have at one time or another been affected by some one of the several forms of tuberculosis.

It has been claimed that all people at some time have been subject to this infection.

Mixed infection of tubercle bacilli with pneumococci, streptococci, staphylococci, and other pathogenic bacteria has been proved by examination of the blood and diseased areas.

Special Forms of Tuberculosis.—*Organs Affected.*—The lungs, pleura, lymph nodes, peritoneum, bones, joints, and testicles are most commonly the seats of the disease. More rarely it affects the ovaries, liver, spleen, pancreas, and muscular tissues. Osler found 275 tubercular cases in 1000 autopsies, and in these, with few exceptions, the lungs were involved.

The order of frequency of the disease in other parts, with special

reference to surgical tuberculosis, based upon an estimate made from clinical reports, is approximately as follows: Bones and joints, 78 per cent.; lymph nodes, 14 per cent.; skin and connective tissues, 5 per cent.; genito-urinary organs, 2 per cent.; and mucous membrane, 1 per cent.

Tuberculosis of Bone.—As already stated, the pathological changes which occur in bone in the course of this disease are much the same as in other parts. Through circulatory channels or leukocytic agency the bacilli become arrested in the bones, either in the arterioles or in the blind cul-de-sacs of the venous terminals, which rest against the epiphyseal cartilages, the sluggish circulation of which favors their lodgment. In this way tubercular foci are formed, and the usual degenerative processes of tubercular lesions occur. Bone destruction and absorption, caseous degeneration, and the formation of sequestra may take place, or the infarct so formed may become enclosed by a capsule which is exceedingly hard and is called an *eburnated infarct.* In the rare instances in which the tubercular process occurs primarily in the shaft, it forms the so-called tuberculous osteomyelitis (osteitis sicca tuberculosa), which is usually progressive in character and of serious prognosis. The abscesses are called cold abscess, as in other tissues.

Joint Tuberculosis.—This occurs through invasion from the neighboring bone or direct affection of the synovial membrane. It is believed that the cartilages, ligaments, and capsules are never the primary seats of the infection.

According to König's classification, there are three varieties of tubercular joint affection: (1) Hydrops (hydrops serosus, hydrops fibrinosus); (2) tumor albus (fungous, granulating joints, "white swelling" —a late form of hydrops); and (3) tuberculous suppurative arthritis.

Symptoms.—The symptoms are those of chronic inflammation. Local temperature, pain, redness, and swelling are usually absent or very slightly marked. Naturally the conditions are modified when there is mixed infection, and the streptococci or staphylococci become active in the inflammatory processes.

Pottinger classifies the symptoms and physical signs of tuberculosis in three groups:

1. Those due to toxemia.
2. Those due to reflex action.
3. Those due to tuberculous processes *per se.*

When the skin is involved in connection with tuberculous bone abscess, its color is altered to a dull red, sometimes having a bluish tinge, and fistulæ form in the vicinity of the diseased area.

Cicatrization following the healing of these fistulous openings is very marked.

The characteristic deformities incident to caries of the vertebræ are well known. The cranial bones, ribs, sternum, jaws, maxillary, and other bones may be affected.

Diagnosis.—In tuberculosis of bones and joints there is an evening rise of temperature, which is to some extent characteristic of all forms of tuberculosis. Pain is not a sufficiently marked or regular symptom to be of much diagnostic value. Tenderness to pressure over the affected areas of bones or joints is usually found.

In bones the presence of a tubercular lesion may sometimes be tested by passing a needle through the diseased portion, and in joints fibrinous deposits and miliary granulations are to some extent pathognomonic. These small fibrous bodies which have been likened to rice or sago grains are quite commonly present, and the sensation to touch that they give when sliding between the synovial layers under pressure with the fingers sometimes assists in making a diagnosis.

The most trustworthy diagnostic method in the early stages is to withdraw some of the fluid or caseous matter and to demonstrate the presence of the bacillus therein. Yet, as will be shown from the following quotation, even this test is not always trustworthy.

"The examination of fluid taken from 24 operative cases several days before operation, all of which were diseases of the joints, and some of which required excisions of the major joints, showed 6 to contain tubercle bacilli, 6 pyogenic organisms, and 12 were sterile. Among the organisms found were streptococci, staphylococci, Bacillus pyocyaneus, and pneumococci. Of the sterile abscesses, inoculation showed two negative and one positive for tuberculosis."[1]

Any stiffening of a joint, whether from slight muscular spasm, or inflammatory adhesions, when not otherwise satisfactorily accounted for by diagnostic indications, should be viewed with suspicion until it may be demonstrated that the cause is not tubercular. The *x*-rays are valuable in ascertaining the extent and character of bone or joint disease and as a guide in determining the advisability of operation.

The maxillary bones are generally regarded as being rarely affected by tuberculosis. How true this may be is perhaps a matter of uncertainty, because the tubercular periostitis and ostitis, with subsequent suppuration and sequestration, so often closely resemble necrosis from other infections to which the maxillæ are prone that it is extremely doubtful if correct diagnosis could be made in many of these cases except by the exercise of unusual care. A careful demonstration of tubercle bacilli in every such case, if this were possible, would, in the author's opinion, alter the record considerably, but whether the result would indicate an increase or decrease of frequency is difficult to say.

Typical tuberculous bone lesions in this region are most commonly noted at the orbital margin of the superior maxillary or at its junction with the malar bone. The nasal and palatal bones are sometimes included by extension of the destructive process. After clinical observation of large numbers of these cases the author feels that only actual demonstration of tubercle bacilli in the diseased tissue can be looked

[1] Young, J. K.: Am. Jour. Med. Sc., August, 1910.

upon as conclusive. Even then the actual cause may be doubtful because there is always a likelihood of mixed infection, and because it is also in this situation that periostitis, caries, and necrosis of bone occur so often, more especially in young children. As has already been stated in the discussion of necrosis, it frequently follows as a sequel of the acute infectious diseases which are common in childhood. Dento-alveolar abscesses are almost always present during this period of life in connection with carious deciduous teeth. Such suppurative foci form an almost constant source from which infection may at any time be communicated to surrounding osseous structures. The weakened resistance of the maxillæ, owing to their filling up with crowns of teeth in the course of development and eruption at this time, renders them more than ordinarily unresisting to the inflammatory processes incident to such infections.

Ulcerative and other destructive forms of stomatitis are likely to be causative factors, and hereditary syphilis not infrequently gives rise to active manifestations at this time of life.

This opinion is warranted by abundant clinical experience in cases of simple infection—as proved by their prompt recovery under proper treatment—that have been allowed to progress and cause extensive bone destruction through the mistaken idea that they were syphilitic or tuberculous.

General Symptoms and Diagnosis.—A detailed study of the general symptoms and diagnosis of tuberculosis would be outside the province of this work.

A brief résumé of the subject sufficient to protect against error in determining the existence of this disease may, however, bear an important relation to the therapeusis or surgery of pathological conditions requiring treatment within our special field.

It should be remembered that the term scrofula, for many years so popular with the medical profession and the laity, is no longer used.

In addition to indications which may be revealed by careful family history and the usual methods of physical diagnosis, supplemented by *x*-ray examination, the following symptoms are important: *Fever* which shows a persistent though not marked afternoon rise of temperature; *chills* and *cyanosis*, although not constant, may indicate acute conditions of this nature; *persistent languor* is always suspicious; *digestive disturbances*, if accompanied by *marked wasting* and without distinctively demonstrable reasons for the loss of weight, are important symptoms; *sweats*, *dyspnea*, and *emaciation* are usually symptoms of the more advanced stages of the disease; *persistent hoarseness* may indicate lung or laryngeal involvement; *circulatory disturbance* is commonly noted in *tachycardia*, which is unaffected by change of position, the pulse running persistently from 90 to 100; *pain* may or may not be distinctive in its manifestations; the characteristic *cough*, *expectoration* and *hemorrhage* are not likely to be overlooked. Careful examination of the mouth, nose, and throat should be given to exclude

local causes of *hemorrhage*. In *sputum examination* it should be remembered that tubercle bacilli are frequently found in the oral secretions of healthy people. On the other hand, the finding may be negative, because it is usually only in the advanced stages of the disease that the tubercle bacilli are found in the sputum.

Tubercular affections of the *glands* related to the mouth and neck, which are so common in children, are often troublesome in diagnosis, because infection from a dento-alveolar abscess may lead to chronic enlargement of the nodes, which closely resembles the result of tubercular infection. It is useful to remember that dento-alveolar abscess and other septic conditions of the inferior maxilla are adherent, whereas an enlarged lymph node, even though it may be situated close to the inner side of the jaw, is more or less freely movable. This distinction does not follow when the lymph node is secondarily infected from a tooth abscess and independently enlarged. It is a good rule in such cases to examine carefully not only the teeth for evidence of caries and septic conditions, but the portions of the jaws in which the crowns of erupting teeth may lie, because these are sometimes causes of septic infection when the outward symptoms of pus are not noticeable. Differentiation must also be made from malignant and other tumors affecting the jaw and neck, from cysts, syphilis, and Hodgkin's disease. Distinction in such cases must depend upon recognition of positive evidences of tuberculosis, or the symptoms by which the other diseases may be recognized and enumerated in the description of these subjects.

Tests for Tuberculosis.—*The Tuberculin Test.*—After the first period of enthusiasm with regard to its curative virtues when brought forward by Koch in 1891, tuberculin was generally, and, as is now known, undeservedly, condemned, because of its improper and unscientific use. At the present time its value as a diagnostic agent is universally recognized and its therapeutic possibilities appear to be constantly advancing.

Tuberculin (old) prepared according to Koch's original process is now almost universally used for diagnostic purposes. Its injection gives a local reaction believed to be due to a combination of the tuberculin in the blood with the antibodies in the focus, manifested by swelling and redness in the tubercular lesions. The general reaction which is similar to that of other bacterial toxins, includes, fever, malaise. sensations of chilliness and pain in the head and joints, alterations in the pulse, and possible nausea and vomiting. The rise in temperature may be slight or quite marked, and indeed, there may be almost complete absence of active manifestations of the other symptoms. Small doses are advisable for many reasons.[1]

Cutaneous Reaction.—*Von Pirquet's method* is to scrape away the epithelium, as in vaccination, in two areas an inch or more apart. One is moistened with tuberculin, one part; five parts carbolic glycerin,

[1] Minor, Charles L.: Krebs's Tuberculosis, p. 343.

and two parts normal salt solution. The other is left as a control. In non-tuberculous individuals the reaction is alike at both points. With tuberculous subjects a reddened area, becoming more or less encrusted, appears during the first twenty-four hours.

Inunction Test.—Ligniere and Moro found that rubbing a strong solution of tuberculin on the skin produced reaction, without abrasion. For this purpose tuberculin ointment is now prepared by reducing tuberculin (old) to an anhydrous condition and incorporating it in a lanoline base This should be rubbed for four or five minutes over an area of several inches. In from twenty-four to forty-eight hours a zone of redness appears with slight swelling and papular formation.

Wright's Opsonic Index Test.—By comparing the serum of one suspected of being tuberculous with mixed sera of several individuals known to be free from tuberculosis, there is obtained an index to the diagnosis and the treatment. It is believed that the phagocytic activity of the tuberculous person's leukocytes varies from the normal with regard to tubercle bacilli.

The Ophthalmic Reaction.—A 1 per cent. solution of dried tuberculin, alcohol precipitate, in sterile water is dropped into the conjunctival sac. In from twenty-four to forty-eight hours, with a tuberculous patient, the reaction will be experienced in a feeling of discomfort in the eye, which is quickly followed by conjunctivitis. Profuse lacrimation takes place and a fibrinous exudate collects in the region of the inner canthus. The reaction reaches its height in the course of eight to ten hours and lasts two or three days.

All the tuberculin tests must be considered in connection with other symptoms, because there is so much variation in individual cases that wrong conclusions may easily be reached. The author's experience with the ophthalmic test, based upon observation, and the results as reported to him from a number of institutions in which this test has been more or less extensively applied, is as follows: While there can be no doubt that the reaction does take place in tuberculous patients, there is danger of exciting serious ocular disturbance, and it is unnecessary to incur this risk, since it is admitted that the cutaneous and other methods of tuberculin diagnosis are equally if not more trustworthy and do not have this element of danger. While serious eye results may be exceptional, it is generally admitted that any inflammatory disease of the eye contra-indicates the test, and since only oculists can safely determine the existence of such conditions with sufficient accuracy, it is obviously not a method for general application.

Prophylaxis.—Notwithstanding its terrible ravages in spite of the efforts to control the devastation it causes, tuberculosis is a preventable disease. Enumeration of the methods that are being projected and adopted for its control would mean a complete résumé of the history of modern sanitary science.

It is sufficient to state that all depend for their usefulness upon a few simple basal principles.

Destruction and prevention of the propagation of the germs constitute the first principal division. The increase of individual health, in order that the human body may be in the best possible condition to resist and throw off the infection, covers the second group of important considerations.

Direct sunlight is the great enemy of tubercle bacilli, destroying them in from two to ten minutes. A diffused light, according to Weinzirl,[1] destroys them in from twenty-four hours to one week. Moist cultures are much more readily affected than dry ones. In the dark corners of rooms tubercle bacilli retain their vitality for long periods of time.

Oral hygiene, as commonly considered, in providing for proper mouth disinfection, the cleansing of the teeth, the prevention of dental caries and other diseased conditions of the teeth, alveolar structures and gums, is now becoming more and more recognized, as its possibilities are demonstrated in the course of development of the now world-wide movement in this direction.

The value of these measures in contributing to more widespread general health, and particularly to the prevention of tubercular affections, is as yet only half-appreciated. With full recognition of this it must still be urged that there is, however, a broader and more important aspect of the subject which should be directly under the control of those who treat diseases of the mouth and teeth. As has been shown in the discussion of the subject of maxillary readjustment, this consists in the prevention and correction of defective nasal development (see pp. 554 and 563).

Through the early loss of teeth, or by permitting individuals to reach maturity with irregular or contracted dental arches and the high, narrow palatal vaults that are associated with these defects, both the size and form of the nares are directly affected, as evidenced by the sections of dogs' heads on page 566.

It seems hardly necessary to urge that proper nasal respiration and the free oxygenation which depends upon the proper exercise of this function lie at the very base of the whole structure of prophylaxis with regard to tuberculosis, even more than other affections. No better general remedy can be instituted than the improvement which invariably follows the widening of the nares by mouth expansion, as described on page 556, and the immediate increase in the supply of nature's most dependable agent in combating this infectious disease. This should be a routine measure with children, and even young adults whose upper dental arches and palatal vaults are narrow.

Figs. 54 and 55 are photographs of a boy patient nine years old who was referred by Dr. G. L. Bellis, of Muirdale Sanitarium, Milwaukee, with all the symptoms of acute pulmonary tuberculosis—temperature, night-sweats, loss of flesh, hoarseness, and all the classical

[1] Krebs: Tuberculosis, p. 49.

symptoms of this affection were present. An appliance was inserted and his upper dental arch spread. Thirty days later his mother reported that he had gained in weight and in height; one inch in chest measurement and one inch around the waist. He is now quite well (Fig. 56).

In summary it may be said that among the most important measures to be adopted in the prophylactic treatment of tuberculosis, there should be included all methods known to dentists and oral surgeons whereby the cleanliness of the mouth and its secretions, the life and the usefulness of the teeth, and the preservation of the perfect form of palates and dental arches, together with the developmental effect of these upon other parts, may be enhanced.

FIG. 54.—Front view of tubercular boy.

FIG. 55.—Back view of tubercular boy in Figs. 54 and 56.

Treatment.—The local treatment of tubercular abscess or necrosis in the maxillæ does not differ materially from other similar affections due to any other cause. The removal of diseased tissue or bone and of sequestra, if present, with packing and treatment, as described under the general heading of Necrosis of the Jaws (p. 336) is indicated. To supplement this all the influences which are known to be beneficial in other forms of tuberculosis should be brought to bear in assisting the overthrow of the local infection. Fresh air, highly nourishing food, and the best possible hygiene that the circumstances of the patient will permit are important.

How far the general treatment of patients may in the future be

incorporated as routine treatment in connection with surgical tubercular cases, it is difficult to say. But the Stevens Point Sanitarium, which is the first institution regularly to adopt the combination of surgical hospital treatment in connection with institutional methods in the treatment of individuals ordinarily considered as strictly surgical cases, may by its example and results lead to the general adoption of this combination.

Removal of tubercular glands is not as generally resorted to at present as formerly, although complete and extensive dissections were generally effective. Tuberculin treatment, curettement, drainage, and local applications to the affected glands are found in most cases to be sufficient.

Fig. 56.—Same boy as in Figs. 54 and 55 after recovery.

Murphy[1] states that he has not made a typical cervical adenitis operation in over six years. All except the suppurating nodes are cured with tuberculin. The suppurating nodes should be drained and curetted, not dissected.

Summary.—As an important matter of general information, especially for those who treat pathological conditions, tubercular or other, in any part of the human body, it seems best to include the following summary:[2]

The following leaflet, by Dr. George H. Krebs, of Los Angeles, California, submitted in competition for the best educational leaflet for mothers, was awarded a gold medal at the International Congress on Tuberculosis in 1908:

Tuberculosis a Disease Responsible for Untold Sorrow to Mothers.—Tuberculosis, or consumption, is a disease which robs the mothers of the world of one out of every ten children.

The causes of this disease are known, likewise the means whereby it may be prevented.

Every mother owes it to herself and her family to know about tuberculosis, so that the lives of her children may not be placed in peril.

[1] Editor Practical Medicine Series, 1911, ii, 134.
[2] Krebs: Tuberculosis, Appendix, pp. 808, 809 and 810.

The Frequency of Tuberculosis.—In the United States more than 150,000 persons die every year from tuberculosis. The great majority of these persons are in the prime of life. Many of these persons are married, and their untimely death means dependent families to be cared for by the State.

The loss in money to the United States from these preventable deaths every year amounts to more than three hundred million dollars. The suffering caused by the disease is impossible to estimate.

Two Important Facts about Tuberculosis.—Tuberculosis is preventable. Tuberculosis is curable.

These are most important facts worthy of widest circulation, especially since contrary ideas prevail.

Universal prevention and cure of this disease will result only when there is universal effort against it.

In this work of prevention and cure the mothers of the world can wield a tremendous influence.

The world counts on the aid of the mothers, for what mother would condemn either her own or any other child to an unnecessary death?

What Are the Causes of Tuberculosis?—First, there is an exciting cause, which is a very small plant called a germ. There can be no tuberculosis unless this germ be present in the body.

Secondly, the person who takes this disease has a body that is favorable to it. Any person whose health and strength are run down is predisposed to tuberculosis, because in such a person there is not much resistance.

The two things necessary then for tuberculosis are the presence of a certain germ in the body of a person whose health for any reason has been run down.

What the Germ Does in the Lungs.—When the germ gets into the body of a person who is run down in health, it finds a soil suitable for its growth and produces the disease called tuberculosis.

The germs produce little granules called tubercles, which may later become little ulcers or abscesses.

Poisons are also thrown out by the germs and get into the blood, and these poisons cause most of the symptoms of the disease.

What Are the Symptoms of Tuberculosis?—The symptoms are different, according to the stage.

It is the symptoms of the early stages that should be learned, for it is then that cure can be brought about and lives saved. What are these symptoms?

The disease usually comes on in very slow and mild fashion. That is what throws the persons infected off their guard. There may be nothing more than a tired feeling, especially after work, a lessened appetite, some loss of weight, and perhaps an occasional cough.

As the disease grows worse, these symptoms do likewise. The loss of weight may be very noticeable; there may be fever and night-

sweats. With the more frequent cough much sputum may be expectorated.

In the far-advanced stages some of these symptoms, like cough, loss of weight, and fever, may be very pronounced. Then we have the picture of the "consumptive."

How May Tuberculosis be Prevented?—Tuberculosis may be prevented by doing two things: (1) Killing the germs that cause the disease. (2) Having people become healthy, so that they will not be predisposed to the disease.

How Are the Germs to Be Destroyed?—The germs are scattered far and wide in the sputum which is coughed up by consumptives. One consumptive can cough up in a single day several billions of these germs.

When this sputum dries as dust the germs are blown about in all directions; they get into the air we breathe and on the food and things we eat and handle. In this way every person at some time in life probably gets the germs into his body.

To destroy these germs, all that is necessary is to destroy the sputum.

If sputum be coughed into paper cups or napkins, these can be burned and the germs destroyed. For spittoons, disinfectant solutions like lye should be used.

Coughing in people's faces or spitting on the streets, and especially on floors, is dangerous.

How May the Predisposition of a Weakened Body Be Overcome?—Bodily weakness, that is, the predisposition to tuberculosis, may be overcome by right living, particularly by breathing pure air, eating nourishing food, and getting the proper proportion of rest and exercise.

A child weak at birth should be guarded, and as it grows older made to spend much time outdoors.

Children weak from diseases like measles or whooping-cough should not be neglected. These and kindred diseases are often responsible for tuberculosis being set up later on in life.

Children should not be made to work at too early an age, or allowed to study so hard as to interfere with health.

The food should be eaten slowly, and should always be nourishing. If cow's milk is used, it should be obtained, if possible, from a dairy having no tuberculous cattle.

The living and sleeping rooms of the family should always be well ventilated. The human body, if it is to be in a healthy state, must have pure air. Bedrooms should not be overcrowded, and single beds are advisable.

The above rules should be observed by grown-up persons as well.

These simple rules are worth observing, because a healthy body is usually able to overcome tuberculosis, but a weakened body is not.

How May Tuberculosis Be Cured?—Tuberculosis may be cured by the same measures which prevent it, namely, by making the body

stronger so that it will be able to kill the germs that have gotten into the tissues.

Pure air, good food, plenty of rest treatment, cures more people of tuberculosis than all the medicines that are known.

Avoid patent medicines for tuberculosis, particularly cough medicines, as these usually contain alcohol and opiates, which, though they may make the patient feel better, usually allow the disease to grow worse.

The above methods should be carried out under the advice of a private or dispensary physician who has made a study of the disease. "Develop healthy bodies."

SYPHILIS.

Syphilis is an infectious disease caused by the Spirocheta (treponema) pallida. It is a constitutional affection that becomes chronic, and is of indefinite duration. Its manifestations affect almost every part of the body, and in a general way are said to represent primary, secondary, and tertiary stages, to which some writers add a parasyphilitic stage.

Syphilis May Be Hereditary or Acquired.

Hereditary Syphilis.—In the transmission of syphilis by heredity the infection takes place in the following different ways:

The fetus may be infected by the semen of a syphilitic father at the moment of conception, or similarly by the ovum of a syphilitic mother. It may also be infected through the placental circulation; or receive infection in parturition from lesions of the mother's genitals

The conditions governing the hereditary transmission of syphilis vary greatly. A syphilitic father may infect both wife and child, or he may infect either without the other. A syphilitic mother may bear an untainted child, although this is admitted to be of rare occurrence; and the appearance of late tertiary symptoms in such mothers lends color to the assumption that freedom from infection was only apparent. Colles' law, "that the apparently healthy mother of a syphilitic child cannot be infected by the child," is subject to occasional exception in cases that have been reported of mothers who have developed chancre of the nipple and general syphilis after nursing their infants.

The danger of infection from the syphilitic father becomes markedly less after two years and seldom occurs after five years, but even then there is no certainty of safety. When proper treatment is given the danger is practically *nil* after five years, and it is claimed that in many cases infection is not transmitted after two years.

A syphilitic mother may give birth to syphilitic children long after her own symptoms have ceased to be evident. There appears to be a gradual tendency toward lessening of the virulence of the infection with each succeeding childbirth; but no rule can be established in this respect, because with the syphilitic mother there may occur in almost

any order, death *in utero*, monstrosities, abortions, children born with syphilitic lesions, or without noticeable imperfection at birth, but which may develop luetic symptoms at a later period.

Symptoms.—There are no primary lesions or chancres in hereditary syphilis; but in many other respects its manifestations are much the same as in acquired syphilis, except for such differences as are caused by interference with both intra- and extra-uterine development. These influences, however, are usually responsible for clinical symptoms which vary considerably from the results of the same virus in acquired cases.

The destructive influence of syphilis as affecting fetal and post-natal development is characterized by deformities of the cranium, spine, extremities, chest, and other parts.

Syphilitic children are often born prematurely. The wrinkled appearance of their faces marks the type of one of the stages of development which gives a senile appearance, the old man's countenance. The skin is creased and loose, and a macular eruption often occurs. Extreme susceptibility to snuffles in infants indicates inflammation in the nasal mucous membrane. The eyes are apt to be inflamed and sunken. Lesions of the nervous system may manifest themselves in many forms.

Digestive disturbances assist in causing restlessness, anemic appearance, insufficiency of growth and weight. All these symptoms are characteristic, but not necessarily indicative of syphilis.

The skin is affected by various forms of eruption. These are maculopapular eruptions, squamous, bullous, or pustular, and show a tendency to regional distribution or to become confluent.

These indications are not always present, but syphilitic children may be born quite healthy in appearance and yet develop late symptoms of the tertiary type, or may appear to be perfect and yet have visceral defects that will lead to fatal lesions shortly after birth.

Although the lining membrane of the nose is highly susceptible, the mucous membrane of the mouth is not so commonly affected. There may be ulcers upon its surfaces that are difficult to distinguish from aphthous stomatitis, or a notable tendency to fissures and crust-covered cracks upon the corners of the mouth.

The scars from these cracks when healed are important indications of hereditary syphilis.

The Teeth.—The teeth bear the stigmata of hereditary syphilis chiefly in two recognized forms; although it is admitted that this disease may be accountable for many dental malformations and abnormalities.

Hutchinson's Teeth.—They are named after Jonathan Hutchinson, Sr., who first directed attention to them as evidence of syphilitic heredity. They are small, peg-shaped, and marked upon the incisal surfaces with crescent-shaped notches (Fig. 57). The central incisors are most affected and inclined toward each other.

Fournier's Teeth.—This is a descriptive term sometimes applied to the more common appearance of erosion principally affecting the first molars, which has been represented as one of the stigmata of hereditary syphilis. That the peculiar form of the tooth crowns and other marks of arrested development upon their enamelled surfaces, which are typical of Hutchinson's teeth, or even the defects described by Fournier, might be and doubtless are often due to syphilis, is beyond dispute. This is owing to the fact that syphilis is usually most active at that stage in the development of the central incisors and first molars when arrested development might be expected to affect them at these points. On the other hand, it is well known that there are many causes of arrested development, other than syphilis, which leave the record of their occurrence upon teeth in the form of grooves, pits, eroded surfaces, and otherwise.

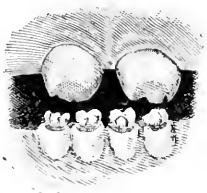


Fig. 57.—The teeth of hereditary syphilis at maturity.

Patients having such teeth are commonly met with in the practice of most dentists.

Much harm has already been done through misjudgment in making an attempted diagnosis of hereditary syphilis, without other corroborative indications.

Faulty metabolism, due to many causes which may affect the mother, and later the diseases of infancy, may be accountable for the imperfect form of tooth crowns and marks upon their surfaces, which in some cases might easily simulate those dogmatically stated to be pathognomonic of syphilis alone.

As one of the diagnostic indications to be considered only when other signs of hereditary syphilis are present, Hutchinson's teeth have a place; but beyond this their significance should not be relied upon.

Bones.—The bones are chiefly affected by *osteochondritis,* which leads to distortions and enlargements of bones at the epiphyseal line and *periostitis,* which may cause enlargement or destruction. Less commonly all the other lesions of bone that occur in acquired syphilis are also active.

Dactylitis, an enlargement of the phalanges of fingers or toes, occurs more frequently than in acquired syphilis.

Joints.—*Arthritis* appears, if at all, as a complication of osteochondritis.

Muscles.—The muscles sometimes suffer fixation through extension of inflammatory processes originating in periostitis.

Lymph Nodes.—These are not usually affected except secondarily to other lesions.

Diseases of the ear are common among these children, and are caused by pathological conditions of the nose.

The liver, spleen, lungs, and testicles usually bear evidence of their involvement.

Syphilis of the Third Generation.—A safe clinical position with regard to the transmission of hereditary syphilis to the third generation is to assume that it can be so transmitted, and may be responsible for dystrophic stigmata similar to those of hereditary syphilis of the second generation.

At the same time due allowance must be made for the rarity of such cases, as generally acknowledged, and the almost prohibitive difficulties that lie in the way of definite proof that the affected offspring of a third generation is absolutely free from suspicion of acquired syphilis; that both the parents were likewise proved never to have acquired this infection; that one or both of the grandparents actually had syphilis, and finally that the lesion or dystrophy of the individual in question is undeniably due to syphilis.

It is these questions that have led to differences of opinion between such authorities as Hutchinson, who does not, and Taylor and Fournier, who do believe that syphilis is transmissible to the third generation, and the many syphilographers whose opinions upon this subject are less extreme.

Acquired Syphilis.—Etiology.—Syphilitic infection is acquired by sexual intercourse, or extragenitally by non-sexual inoculation.

A syphilitic lesion in contact with the most minute abrasion, even though it be microscopic, its presence unsuspected, and the contact momentary, may be sufficient for the infection to be transmitted.

It is claimed to be impossible to inoculate by subcutaneous injection. The virus from chancres and mucous patches is the most active in infection. But inoculation may take place from the blood or semen of a syphilitic, from gumma, and from any of the secretions. Even when the inoculating fluid does not appear to contain Spirochetæ pallidæ, inoculations have been successfully made with spirochetæ in the resulting lesions.

Extragenital Inoculation.—An attempted recital of many of the infinite number of different and often surprisingly unusual means by which the syphilitic virus has been transmitted without sexual intercourse, and the anatomical situations in which the initial lesions have from time to time been found, would be quite useless. But the following table, prepared by Bulkley and reported by Keyes,[1] may serve to give an idea of the relative frequency with which such inoculations have occurred in different parts of the body.

	Cases.		Cases.
Lip	1810	Perigenital region	77
Breast and nipple	1148	Legs and thigh	73
Buccal cavity	734	Forearm	59
Fingers and hand	462	Neck	47
Eyelids and conjunctiva	372	Gums	42
Tonsils	307	Forehead and temple	37
Throat (deep oral and nasal)	264	Ears	27
Tongue	157	By vaccination	1863
Chin	146	By cupping and phlebotomy	745
Cheek	145	By circumcision	179
Trunk	100	By tattooing	82
Nose	95		
Anus	87	Total	9058

[1] Syphilis, p. 56.

The striking lesson to be gleaned by study of this chart is that the lip, buccal cavity, fingers, and hand, so greatly outnumber all other sources of infection save vaccination (which under modern methods is no longer a matter of common occurrence), and the breast and nipple.

Thus it will be seen how constantly oral surgeons and dentists are in the presence of the danger, either of infecting themselves, or of transmitting the disease through their instruments or hands to patients.

Dr. William Carr, of New York, who has had wide experience in dealing with syphilitic mouth affections, was able in one of his cases to trace the extragenital infection to a dentist, who being the only one practising in a small town, had under his care at the same time one of Dr. Carr's patients who was syphilitic, and another one who came for treatment afterward. In the latter the initial sore appeared in the mouth and was undoubtedly the result of infection by the dentist's instruments.

Many such cases have been previously reported, but it is not always possible to have such an uncomplicated record of proof as was offered in this instance.

Infections of dentists, physicians, and surgeons by patients are much more easily proved, and have been of sufficiently frequent occurrence to warrant every precaution that may serve to guard against inoculation in the course of operations, or treatment of patients, whether known to be syphilitic or otherwise.

Kissing, the introduction into the mouth of instruments, pencils, spoons, pipes, cigars, or cigarettes that have touched the lips or mouths of luetic individuals, and the pernicious use of public drinking cups, and other similar means of spreading the infection are too well understood to require elaboration.

It is more important to attempt to measure the exact danger of such opportunities for conveying the virus as may occur in ordinary social intercourse.

On every hand there is evidence of the uncertainty of establishing fixed rules.

The great majority of syphilitics cease to be infectious after three years. After four years the chance of transmitting infection is estimated to be one in a hundred, and after five years the danger is believed to be so slight as to be hardly worthy of consideration, and yet even the possibility of infection, no matter how vague, must be deemed a social menace until more definite limitation in this respect may be established.

The marital relation for syphilitics is governed by the rule that "*marriage of a syphilitic is permissible only after five years, during the last two of which he has been without symptoms.*"

Three years of proper treatment with conscientious coöperation upon the part of the patient is generally believed to assure safety in marriage, but doubt in this respect is suggested by cases reported in which infection has occurred after longer periods of time.

Marriage, while not necessarily forbidden, should only be contracted after two years, absolute freedom from symptoms, and then only under careful medical supervision.

Immunity, in some degree at least, has been claimed for certain races and individuals, as indicated by the negro race, which seems to suffer less severely than the white, and authentic reports of men who have cohabited with women during the actively dangerous stage, and *vice versa,* without acquiring the disease, although others who have had coitus with the same individuals were infected. But even these examples are subject to so many modifying circumstances that positive conclusions appear to be unwarranted.

Efforts to create an artificial immunity by the injection of blood serum of syphilitics, or the juices of their lesions, have thus far been unavailing.

Symptoms.—Following sexual intercourse, a slight abrasion or several herpetic vesicles may or may not be apparent, or, if the infection be extragenital, the lesion through which the virus gains entrance may be noticeable or such as not to attract notice. Following this there are no unusual symptoms until after the chancre appears upon the glans penis or foreskin, or at any other part of the body where inoculation has taken place.

Period of Primary Incubation.—The period of primary incubation is the time between the inoculation and the appearance of the chancre or initial sore. This varies from ten days to six weeks. Usually in from three to five weeks a single sore, at first resembling a pimple, is developed at the point of inoculation. This increases in size, becomes indurated, and later eroded or ulcerated upon its surface. About ten days later, in typical cases, the glands in one or both groins begin to swell. Neither of these symptoms may be such as to create much discomfort, as the chancre is not very sore, and the glands may not attain sufficient size to give trouble. In this way these symptoms sometimes pass unnoticed.

In the course of three or four weeks the chancre heals and leaves a hard lump under the epidermis, which is typical of these cases.

In women the chancre is often so insignificant in appearance and symptoms as to attract no notice whatever, and it is only with the beginning of the next stage that such patients become aware of their own condition.

Secondary Incubation Period.—The secondary incubation period begins with the chancre and ends with the appearance of the secondary symptoms, one to three months later in ordinary cases, but sometimes not until five months afterward.

Secondary symptoms may not develop if proper treatment has been promptly instituted, or may even be overlooked under other conditions. The secondary manifestations of syphilis are in the nature of an acute toxemia and local lesions.

Secondary toxemia is noted in variable degree in the form of secondary anemia, general anemia, loss of body weight, slight fever, prostration,

and other symptoms which might easily be confused with typhoid fever, malaria and similar affections, until the secondary lesions become noticeable.

Secondary Lesions.—In typical cases the characteristic skin lesion appears in the form of a macular or maculopapular eruption.

The scalp is covered with moist encrusted papules or scabs.

The mucous membrane of the mouth and throat is more or less affected by erosions.

The lymph nodes of the neck become enlarged, and there is the usual symptom of sore throat.

Headache of general or neuralgic character and painful affections of the muscles and bones, particularly in the regions of the joints, are more or less marked.

At a subsequent period, after the first outbreak of secondary symptoms has entirely disappeared, other lesions are likely to appear. These are exceedingly variable, both as to time of appearance and character, and may affect almost any tissue or organ of the body. Quite often they do not appear at all, especially with patients under treatment. No accurate estimate can be made of the length of time that must elapse before the secondary symptoms cease to recur.

All these features are well covered in the following tables prepared by Keyes:

DURATION OF SECONDARY SYMPTOMS IN 280 CASES.

	Cases.
Less than 1 year	17
1 to 2 years	82
2 to 3 "	79
3 to 4 "	25
Less than 4 years[1]	49
4 years	17
5 "	6
6 "	2
7 "	1
8 "	1
9 "	1
Total	280

LATE SECONDARIES AMONG 2000 CASES.

	Cases.		Cases.
4 years	51	17 years	1
5 "	44	18 "	2
6 "	34	19 "	1
7 "	13	20 "	4
8 "	11	21 "	1
9 "	14	23 "	2
10 "	9	24 "	1
11 "	8	25 "	4
12 "	11	30 "	1
13 "	8		
14 "	1	10 to 30 years	60
15 "	4	4 to 9 "	167
16 "	2		
		Total	227

[1] Duration not quite accurately known.

Tertiary Symptoms.—At any time after the secondary incubation period the tertiary lesions may occur. (Some authors claim that in rare cases the tertiary may even precede secondary symptoms.) Or they may not develop for many years, as indicated by the results of both Fournier's and Keyes' experiences, which have been tabulated by cases in the following form:

INCIDENCE OF TERTIARISM.

	Fournier.	Keyes.
First year	278	112
Second year	453	149
Third year	471	142
Fourth year	388	79
Fifth year	357	61
Sixth year	326	64
Seventh year	274	39
Eighth year	211	25
Ninth year	195	20
Tenth to fourteenth years	736	80
Fifteenth to nineteenth years	423	26
Twentieth to twenty-ninth years	304	23
After the twenty-ninth year	83	4
Total	4499	824

These are the actively destructive manifestations of syphilis. They differ from the secondary lesions in being less infectious (are commonly believed to be non-infectious); in having greater malignancy, and a tendency to attack the deep in preference to superficial structures. Any organ in the body may be affected. Tertiary syphilis occurs in the form of a syphilitic granuloma (gumma), or as a diffuse, interstitial sclerosis; in the mouth ulcerating syphilis of the soft palate, and tonsil; necrosis of the maxillary bones, and particularly of the hard palate with the usual perforation.

Gumma of the tongue and cheek is a frequent result of tertiary syphilitic processes.

Syphilitic Dystrophies or Parasyphilides.—These are functional derangements of apparently toxic origin, and while they are common among patients affected by syphilis of long standing, yet the fact is that similar affections appear as the result of other systemic diseases. It necessarily follows that they are not always syphilitic, and their inclusion in description of late syphilitic manifestations must be accepted with this understanding.

Arteriosclerosis, aneurysm, spinal paralysis, and other neuroses and trophic changes of various kinds affecting organs or divisions of the body are examples of parasyphilides.

Diagnosis.—The subject of the diagnosis of syphilis in its presentation to practitioners of all divisions of medicine demands an advance word of caution, and for many reasons this is especially necessary for those who treat diseases of the mouth. Not only are luetic lesions in all stages frequently evident in the oral region, but outbreaks of many other affections as well, and many times these simulate lues so

closely as to make diagnosis extremely difficult. There is a predisposition to diagnostic error which may influence either patient or operator in this regard, and frequently leads to grave results.

Too often physicians and dentists are prone to consider as syphilitic almost any affection that may resemble a syphilitic lesion, if its etiology be obscure, and it resists ordinary therapeutic or surgical measures. On the other hand, patients who know themselves to have been exposed, or who may at a previous time have had symptoms of syphilis, are often in a panic of fear over any slight manifestation of disease that may be so construed, and thus through an excited imagination mislead the diagnostician by exaggerated descriptions of their conditions. Over and over again in the author's practice cases such as the following have occurred:

A young man about town had been under treatment for sore throat and ulcers upon the mucous membrane of his mouth that were assumed to be of syphilitic origin and were so treated. It was found to be an ulcerative stomatitis primarily induced by uncleanly, ill-fitting dental bridge-work, which caused pericemental inflammation and infection of the surrounding mucous membrane, aided by excessive cigarette smoking and a generally depleted systemic condition. The symptoms promptly responded to local treatment as soon as the irritating bridge-work was removed. During several years' observation of the case no syphilitic symptoms appeared to cast doubt upon this diagnosis.

Another case was that of a vaudeville actor who had been affected with syphilis for many years and was at the time suffering from necrosis of his lower jaw, which had steadily become worse under previous antisyphilitic treatment. Careful review of the case led the author to believe that excessive use of mercury was responsible for the trouble, and not syphilis.

All administration of mercury was stopped, and the case treated as one of ordinary necrosis, with prompt recovery. In this case what proved to be mercurial necrosis, aggravated by increased doses of mercury, cost the patient about two and one-half inches of his mandible which came out in the form of a sequestrum as completely as if resected. Admitting that the findings of this case rest wholly upon clinical evidence, it is at least fairly certain that the case would have become much more serious if mercury had not been stopped, and still more so if it had been continued in increased doses. If space permitted, the moral and social sides of the question of ill results following wrong diagnosis due to syphilophobia might be just as strongly illustrated as its clinical aspect.

On the other hand, whole pages might be filled with examples of disaster following failure to diagnosticate syphilis, and of treatment given for other affections when this was the real disease.

Diagnostic Indications and Methods.—*Clinical.*—History: Scars or other evidence of previous lesion, present symptoms, and the effect of treatment.

Laboratory.—Identification of Spirocheta pallida, specific reaction, examination of blood and tissue, and inoculation of monkeys.

To facilitate differential diagnosis, the immediate indications of syphilis can best be studied in comparison with those of other affections, having objective symptoms likely to cause confusion.

Clinical Diagnosis.—CHANCRE.—This is also known as hard chancre, Hunterian chancre, indurated chancre, syphilitic chancre, and primary sore.

This lesion appears at the point of inoculation.

In a large percentage of cases the surface becomes *eroded,* the color varying from dark red to dark gray, and it is covered by a slight seropurulent discharge. All chancres have an indurated base, which may be felt by pressure between thumb and finger, but in the eroded form this is much less noticeable than in the typical *Hunterian chancre,* which has a large base surmounted by a distinct ulcer. A rarer form than either of the other two is the indurated papule, which is usually found on thick-skinned surfaces. These papules are small, dark, red, and flat, with a scaly surface when healing. Other differences in the appearance of chancres are noted in accordance with the different situations in which they may be found. Mixed infection, inflammatory results in various forms, and vegetation may complicate and alter both the course and appearance or chancre.

Chancres of the lip (Plate II, Fig. 1) are the most common of all extragenital chancres. They affect the lower lip most frequently, and are extremely variable in size. Such a lesion may be a tiny papule, or a large, crust-covered mass that gives the patient much distress. Chancre upon the tongue is not uncommon, and is usually upon the dorsum or the anterior border (Plate III). More rarely the lesion is found upon the tonsil, and still less frequently upon the gum.

Generally there is a single initial sore in syphilis, but two or more may be found if the inoculation at several points has been simultaneous or has taken place within a sufficiently short space of time to permit infection at different places. Multiple true chancres have been reported to occur in about 25 per cent. of all cases. Chancre is not auto-inoculable once the lesion has appeared, but it has been proved both clinically and experimentally that after several hours, or even a few days, auto-inoculation is possible.

A very important diagnostic indication is the lymph node, so-called "satellite gland," or, as McKey[1] designates it, the "pilot gland." This is the more or less enlarged gland that is found in the chain of slightly involved lymph nodes that drain the region in which the chancre is situated. The induration often remains, and can be distinguished when traces of the chancre have so far disappeared as to cause them to be overlooked unless attention is directed to the part through recognition of the affected gland.

The following table sums up the differential diagnosis.[2]

[1] Dental Cosmos, August, 1911, p. 921.
[2] Keyes: Syphilis, pp. 246 to 248.

PLATE II

FIG. 1

Chancre of the Lip.

FIG. 2

Mucous Patch.

PLATE III

FIG 1

Chancre of the Tongue.

FIG. 2

Gumma of the Tongue.

The final test is the advent of secondary symptoms.

Vincent's angina is sometimes confused with chancre in diagnosis. The difference may be established by recognition of the characteristic bacillus of Vincent's angina. This affection is accompanied by much greater tenderness and its sore is more superficial than chancre. It does not heal spontaneously as does the primary syphilitic sore, and improves under local treatment, which chancre does not.

Irritation by mouth habits, and irregular or sharp-edged teeth and roots may make sores upon the tongue or buccal mucous surfaces that simulate the appearance of chancre very closely and these may also alter the appearance of true chancre. Removal of the cause and local treatment usually give prompt relief.

Tuberculosis is demonstrated by the presence of tubercle bacilli, the absence of other signs of syphilis, and the irregular hypersensitive character of the ulcer as compared with the shape, induration, and painlessness of chancre.

The Secondary Syphilitic Oral Lesions.—*Sore throat* is caused by ulcerative syphilids (the ulceration papule). These ulcers form principally about the tonsils and pharynx.

The *mucous patch* is an erosive or papulo-erosive syphilid or mucous papule (Plate II, Fig. 2, and Plate VIII, Fig. 2).

Squamous syphilid, or syphilitic leukoplakia, is unusual in secondary syphilis, and is a more constant tertiary manifestation. (See Leukoplakia, Plate VII, Fig. 2, and Plate VIII, Fig. 1.)

Mercurial stomatitis, when salivation is not a marked symptom, is occasionally difficult to differentiate from the ulceration of secondary syphilis. As has been described in one of the author's cases (p. 115), the confusion may lead to serious consequences. The author is convinced that there is no constant feature of the appearance of this form of ulceration which may be depended upon for safe diagnosis. The best test is to stop the administration of mercury and observe results. (For other forms of stomatitis which might be mistaken for syphilis, see pp. 154–156.)

Tertiary Oral Symptoms.—The onset of tertiaries about the mouth and associated parts may occur at any period between one and forty years after contraction of the disease.

Diffuse tubercular syphilitic infiltrations on the lips are caused by confluence of the papules in the form of thick, dark red, scaly, or ulcerated infiltrations of the skin. The administration of mercury, potassium iodid, or other antisyphilitic treatment is the best distinguishing test.

Vegetations or small condylomata also appear upon the lips, and their nature is tested in the same manner.

Thickening of the lips without gummatous degeneration, and showing no surface lesion, sometimes results from a diffuse interstitial sclerosis.

The tongue during this stage may be affected by leukoplakia (Plate

VII, Fig. 2, and Plate VIII, Fig. 1); interstitial glossitis (Plate XIX, Fig. 3) and gumma may also occur (Plate III, Fig. 2).

From a diagnostic point of view it is claimed that the only safe course to pursue when leukoplakia is present is to consider that it is syphilitic until proved otherwise.

The exact distinction cannot at this time be clearly defined between leukoplakia, which is so often evidence of syphilis, and the same affection which is also frequently a forerunner of epithelioma as to be considered a precancerous stage of that disease.

Sclerosis of the tongue causes it to become thickened, lobulated, and shining, and more or less abnormally white. As the process advances, fissures and excoriations occur which are followed by shrinking of the scar tissue with marked decrease in the size of the tongue.

Gumma of the tongue occurs rarely, and when it does it is often associated with sclerosis (Plate III, Fig. 2).

The test of these affections, as of the preceding symptoms, is anti-syphilitic treatment.

The objective symptoms, when compared with those of ephithelioma, admit consideration only in a very general way, because both of these affections are so variable in their characteristics.

Epithelioma is more likely to occur after the fortieth year of age, and affects men most frequently. It may be on the under surface as well as other portions of the tongue, is single, and may be preceded by leukoplakia. In appearance it is a shallow ulcer with thick, everted edges upon a very much hardened base. It bleeds readily and has a foul discharge. The pain is usually severe. The lymph nodes are apt to be enlarged at an early stage, with tendency toward progression in this respect. Medicinal treatment is practically useless.

Gumma has a history of syphilis; it is not confined to either age or sex; it never appears on the under surface of the tongue; it may be single or multiple, and accompanied by leukoplakia. In appearance it is a deep, sloughing ulcer, with its edges undermined and more or less sharp. The induration of its base is not as marked as with epithelioma. There is less tendency to bleed, and the discharge is not quite so offensive. There is usually little or no pain. Lymphatic enlargement is not a marked feature. Mixed treatment is beneficial.

The microscope and other laboratory methods offer a final test in these affections.

The tonsils, pharynx, and soft palate are frequently involved by destructive tertiary lesions in all forms (Fig. 58).

Destruction of tissue by ulcers and resulting cicatricial contraction furnish common examples of syphilitic results that are difficult to overcome.

Syphilitic treatment in these cases furnishes both a test of and a check upon the destructive process.

Perforations through the hard palate, resulting from gummatous

destruction, which usually begin in the nose, are familiar to all who treat diseases of the mouth.

Their diagnosis is usually simple, but the author has had many cases in which portions of the hard palate have been lost, which left a communicative opening between mouth and nose in the region of the hard palate. No history of syphilis could be established, and upon discovery and proper surgical treatment of infection from septic conditions there was recovery, with total disappearance of the constitutional symptoms, which were often more confusing than the local symptoms.

The involvement of the maxillary sinus in these cases, even when there is no opening through the hard palate, is always a matter of importance.

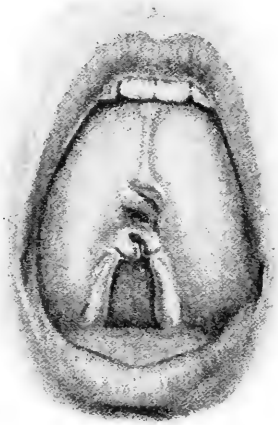


FIG. 58.—Syphilitic destruction of the soft palate.

Differentiation in these cases, in the absence of clear history of syphilis, and without external lesions to act as guides, is sometimes difficult.

Intranasal examination usually discloses ulcerative conditions in the region of the ostium; or the nasal discharges may give the desired evidence.

Carefully taken radiographs will sometimes enable the diagnosis of gumma of the antrum to be made when other methods fail.

The characteristic shape of the bridge of the nose, through loss of its supporting structures, is an unmistakable sign of syphilis, except where accidental injury or necrosis from other causes has brought about a similar destruction. These conditions are usually so clearly understood that there is little difficulty in getting a correct history upon which judgment may be based.

Brain lesions of syphilis, insofar as the mouth and its associated

parts are concerned, have been quite fully covered in the chapter on Diseases of the Nervous System.

Destruction of the maxillary bones may occur as with other osseous structures, through expansion of lesions affecting the soft tissue in the early stages of distinctly tertiary disease which affects bone generally.

Osteoperiostitis, gummatous osteoperiostitis, and *osteomyelitis* may cause destruction of a bone in the form of syphilitic necrosis with exfoliation of a sequestrum; or by slower necrotic processes, by which the bone surface may be destroyed or left in a carious condition.

Osteoperiostitis may cause enlargement, thickening, and alterations in the form of bony growths.

Tuberculosis, neoplasms, and other septic conditions which may lead to osteomyelitis, or chronic irritations from which periosteal thickening or alterations in the form and structure of bones may occur, must all be differential by the recognition of the special cause of irritation or infection, microscopic or other examination of tissue, and by the usual indications of syphilis and the effect of treatment.

Laboratory Diagnosis.—The identification of the Spirocheta pallida is most easily accomplished during the early stages of syphilis. McKee recommends Burrie's method, according to which a drop of serum from the initial lesion, mixed with Indian ink, is employed, "which makes the finding of the organism almost as easy as when the dark field illuminator is employed." He says that there is no difficulty in differentiating the long spiral delicate pallida from the coarser spirochetæ that are found in the mouth, except the Spirocheta dentium, with which it may possibly be confused. They may also be examined alive from the secretion of an infectious syphilitic lesion, in the hanging drop or under a cover-glass; but staining facilitates their identification.

The process of preparing and staining tissue requires much time and skill, and for this reason smears are much more satisfactory in the examination for Spirochetæ pallidæ.

Chancres, moist papules, and mouth lesions are most satisfactory for spirochetæ examination. In the secondary syphilitic lesions the spirochetæ are much fewer in number and more difficult to identify. In the later tertiary lesions there are practically none.

The Wassermann Test.—The Wassermann test seems to outshine all others at the present time in its efficiency. No mention has been made of this in the clinical diagnosis, although it might properly have been added to each and all methods of differential diagnosis. The reason for this is that the Wassermann test is reliable only in the hands of one who is skilful and experienced in its use, and unless carefully made it may be misleading.

R. Weiss[1] describes an easy method for Wassermann's serum, which is as follows:

"The method is based on Wassermann's test, which consists in

[1] Pacific Med. Jour., August, 1910.

combining the serum (amboceptor) with organ extract (antigen) and complement-holding serum and by allowing the mixture to stand for a little while. To recognize whether the complement has been bound or not, blood corpuscles are afterward added and the necessary immune bodies. Usually sheep's blood and the serum of a rabbit treated with sheep's blood are used. If the complement has been used up under the influence of the combination of syphilitic serum and organ extract no hemolysis will take place. If, however, the complement is still free it will attach itself to the sensitized blood corpuscles and will dissolve them. For the modified method it is therefore necessary to have the following materials for the test:

"Physiological salt solution, prepared by dissolving one salt tablet in 12 c.c. of water.

"Antigen (alcoholic organ extract).

"Complement (guinea-pig serum, dried upon filter-paper).

"Amboceptor (hemolytic immune serum prepared against human red corpuscles).

"Patient's serum.

"Emulsion of human red cells (obtained by collecting 10 to 12 drops of blood from the patient, transferring it to the defibrinator, and shaking vigorously until filaments of fibrin are seen attached to the beads).

"Open the bottle containing the antigen and draw the fluid up into the dark amber glass pipette to the graduation. Eject this into tube No. 1. Add 2 c.c. of salt solution to the antigen in tube No. 1. Place 2 c.c. of salt solution in tube No. 2. (This tube from the 'Control.') Place two complements in each test-tube. These must be completely immersed in fluid. Take up the defibrinated blood in the light brown pipette to the graduation mark. Transfer this to tube No. 1. Put an equivalent amount of defibrinated blood in tube No. 2. Let the two tubes remain in at the temperature of the room for an hour. Shake from time to time.

"By means of the ungraduated pipette transfer the contents of one amboceptor bulb to tube No. 1 and a similar quantity of amboceptor to tube No. 2. Shake well. Ten to fifteen minutes later again shake. In a short time the control tube (No. 2) will show solution of the blood corpuscles and the liquid will become red.

"In tube No. 1, if the reaction is negative, the appearance will be identical with those in the control tube (either at the same time or a little later). If the reaction is positive, tube No. 2 will show a sedimentation of the red corpuscles, but no solution, and in about thirty minutes the blood corpuscles will have settled to the bottom of the tube without the blood cells being dissolved, and the supernatant liquid will be clean and light. A certain amount of solution of the red corpuscles may take place in tube No. 1 if it is allowed to stand for some hours."

This appears to be a modification in part of the simplified Wassermann reaction proposed and demonstrated by Hideyo Noguchi in 1909.

According to recent writers[1] the Wassermann test is not absolute, because it is said to occur in a number of other affections.

Baum[2] states that the reaction occurs in scarlatina, pellagra, Hodgkin's disease, leprosy, and in a number of other affections, and does not always occur in syphilis.

Prophylaxis.—Experimentation has proved that syphilitic secretions cease to be infectious after twelve to twenty-four hours, and in approximately six hours if dry.

The importance of this cannot be overestimated when considering the frequency of exposure to extragenital infection and its prevention. The general substitution of individual for public drinking cups, and the installation of bubblers at fountains, with other similar efforts toward protection now being instituted by health boards, are useful prophylactic measures in fighting syphilis in common with other infectious diseases. Prevention of exposure to sexual infection does not seem to make satisfactory progress in spite of much agitation. Control of the social evil at present seems to be beyond municipal regulations, and until this problem is solved, syphilis cannot be wholly prevented.

Prophylactic Treatment.—No radical treatment of the chancre alone can prevent the development of subsequent symptoms, and even wide excision of tissue at the point of inoculation has been proved to be futile. Antiseptics also are useless.

The only satisfactory means of aborting the disease appears to be by inunction with mercurial ointment within one hour, certainly not later than six hours, after inoculation. A salve of calomel 20 and lanoline 40 has been proved to be a preventative when applied experimentally to monkeys and man.

Treatment. — Early Treatment. — In the beginning of treatment patience and firmness must be combined with much diagnostic skill. It seems needless to call attention to the importance of great care in endeavoring to avoid error in diagnosis, and the difficulties in this direction have already been explained. Once the existence of the disease is established the whole scheme of treatment should be gone over carefully with the patient.

Instructions to Patients.—1. The idea must be impressed upon the mind that the condition is not hopeless; but in time, by conscientiously following instructions, much may be done to avoid the evils that might otherwise ensue.

2. It must be made plain that successful treatment depends largely upon self-control and patience to continue the necessary restrictions and therapeutic measures steadily through a period of at least two or three years; that *general hygiene* demands that there be an abstinence from the use of alcohol and the excessive use of tobacco; that the hours

[1] Fox: New York Med. Jour., December 18, 1909. Am. Jour. Med. Sc., May, 1910. Kahn: Am. Med. Record, June 18, 1910.

[2] Editor Practical Medicine, Series 9, 1910, p. 100.

of sleep be sufficient and regular; and that bathing, exercise, moderation in work, and careful selection of simple, wholesome, highly nourishing food be made matters of routine habit.

3. *Habits and rules of life* which may serve to *protect others* from becoming infected must be taught.

4. *Oral hygiene* must be properly explained. Instructions should be given, making it possible an immediate or early detection of any syphilitic lesion that may appear in this region. Such instructions may also be expected to reduce the danger of transmission of the infection through the oral secretions, and aid in the preservation of the teeth and the prevention of local lesions. They should include directions as to the proper use of the toothbrush, disinfection of the mouth secretions with suitable mouth washes, and the habit of daily inspection of the teeth, gums, tongue, and the buccal mucosa generally.

During the administration of mercury the first manifestations of salivation appear in the mouth and around the teeth at the gingival margins. It is of the utmost importance that calculi and bacteria-laden concretions, which, unless properly removed, have a tendency to lodge between and at the necks of the teeth, should not be allowed to excite gingivitis, as this might be mistaken for the beginning of excessive mercurialization, and lead to reduction of the dosage of mercury at a time when it properly should be increased. The effect of such an error might be serious.

The proper care of the teeth must also be urged in the light of a more indirect but not less important benefit in maintaining a healthy condition of the stomach and intestinal tract. This is most necessary in assisting the system to do battle with the infection and to hasten its overthrow, as well as to overcome the ill effects that so often follow the administration of remedies.

Finally, it may be said that with intelligent oral hygienic precautions practically all of the very serious destructive processes which have already been described as affecting both bone and soft tissues may be avoided.

Next to general and oral hygienic treatment *tonics* are indicated, for keeping up the highest state of bodily health and activity is an important factor in preventing the progress of the disease.

Administration of Mercury.—For a long time mercury has been the one dependable agent in the treatment of early syphilis. It may be administered by mouth, inunction, inhalation or injection, with varying estimates of its value.

Internal Administration.—The remedies generally used are: (1) The protoiodide (hydrarg. iodid. flav.), 6 granules of a centigram each, given daily for a minimum dose and gradually increased as indicated; (2) gray powder (pulv. hydrarg. cum creta.), 6 grains daily in 1- to 2-grain tablets; and (3) bichloride of mercury (hydrarg. chlorid. corrosiv.), in $\frac{1}{16}$-grain doses in pill or capsule to avoid its irritating effect.

Many combinations of mercury with tonics are recommended,

according to the fancy of their special advocates. An example of these is the well-known pill of mercury and iron.

℞—Massæ hydrargyri,
Ferri reducti,
Gum tragacanth . . . . . āā ʒj (4 grams)
Glycerin . . . . . q. s. āā
M. et fiant pil. no. lx.
Sig.—One pill after each meal.

Intramuscular Injections.—To avoid the digestive disturbances which sometimes result from the internal administration of mercury and in the hope of securing a more prompt effect, injections into the substance of some thick muscle are employed. The following prescription is among the best of the soluble preparations for this purpose:

℞—Hydrarg. chlorid. corrosiv. . . . . gr. xv–xxx (1–2 grams)
Sodii chlorid. . . . . gr. x (0.6 gram)
Aquæ destillat. . . . . ʒiij (100 c.c.)
Dose.—1 c.c. (♏xv).

Gray oil, according to G. S. Walton,[1] is extensively used with satisfactory results in the Liverpool Skin Hospital for intramuscular injections, and has entirely superseded the oral administration of drugs in these cases. The formula is:

℞—Purified mercury . . . . . 40 grams
Sterilized anhydrous wool fat . . . . . 12 "
Sterilized white petrolatum . . . . . 13 "
Sterilized liquid petrolatum . . . . . 35 "

Five minims of the dose employed are equivalent to 2.5 grains of mercury. As a substitute for gray oil, an emulsion of metallic mercury is employed in the form of a thick mixture of 50 per cent. strength. The following formula is offered by Lafay as being equally as good and much more easily prepared:

℞—Hydrarg. bidestillat. . . . . ʒiiss (10.0 grams)
Albolin . . . . . ʒiij (13.5 grams)
Lanolin . . . . . ʒiss (46.5 grams)
Sig.—Shake. Dose: ♏ij to vj (0.1–0.4 c.c.).[2]

These injections are repeated at intervals of from one to two weeks for a year or longer if indicated. Later they are repeated at intervals of several months, according to indications of the case. The objections to intramuscular injections are pain, the tendency to poisoning, and embolism.

Inunctions.—Inunctions of blue ointment or any of the mercurial ointments are rubbed upon different portions of the body upon successive days to avoid irritation and poisoning. This is continued daily for a period of several weeks or until the patient begins to show slight salivation.

[1] New York Med. Jour., March 26, 1910.
[2] Keyes: Syphilis, p. 176.

Fumigation.—Biweekly fumigations with black oxide ʒij–iiss (8 to 10 gm.) is sometimes employed, or calomel may be used for the same purpose. These vapor baths are useful if properly given, but otherwise are not satisfactory.

Intravenous Injections.—Intravenous injection is usually given according to Bacelli's formula:[1]

℞—Hydrarg. bichlorid.	1 gram
Sod. chlorid.	3 grams
Aquæ destillat.	1000 "

However valuable this method of treatment may be, the well-known objections and dangers incident to intravenous injections would preclude its recommendation except for cases in which there is some urgent objection to other means of administration.

Potassium Iodide and Mercury.—In the later stages of syphilis the mixed treatment of potassium iodide and bichloride of mercury, according to the following formula or some similar combination, has long held sway:

℞—Hydrarg. chlorid. corrosiv.	gr. j–ij (0– 1.2 grams)
Potass. iodid.	ʒij–ʒj (8–30.0 grams)
Syr. sarsaparillæ comp. ad	ʒiv (ad 130 c.c.)—M.

Sig.—One teaspoonful two hours after meals.

In the tertiary stage the author has frequently obtained good results by the use of potassium iodide given in the saturated solution in drop doses. He begins with 5 drops three times a day, increasing 1 drop each time until the limit of endurance appears to be approaching or until 15 minims has been reached; then he gradually goes back to the original number; again increasing to a point slightly beyond the last maximum dose. This procedure is repeated throughout treatment. In this way the danger of iodism is to some extent avoided and the individual tolerance measured. It is well known that both mercury and potassium iodide, particularly the latter, must be administered with due regard for the extreme susceptibility to poisoning that is occasionally encountered in certain patients.

Mercurialism and Iodism.—When mercury is administered the appearance of the dark, inflamed, slightly everted gum borders, loosening of the teeth, increased flow of saliva, and disturbance of the intestinal tract, as well as the ulcerative conditions which sometimes occur when these premonitory symptoms are not noticed, must be constantly watched for, and the dosage must be regulated in accordance with these indications. With potassium iodide, indigestion, the characteristic eruption, tendency to neuralgic pain, localized edema, and congestion of the salivary glands, with symptoms of salivation and albuminuria, are among the symptoms that must be taken as a warning in regulating the dosage of this drug.

[1] Keyes: Syphilis, p. 189.

Arsenic.—The use of arsenic has been actively urged by many syphilographers during recent years. Sodium cacodylate is recommended by Murphy in doses of 1 to 2 grains hypodermically into the muscles. He claims a striking effect of this treatment upon syphilis, mucous patches, and primary chancre, and that the treponemata disappear completely in forty-eight hours. Ulcers of the palate and posterior wall of the pharynx heal as healthy granulating wounds in from three to six days.

Salvarsan.—The most recent as well as the most promising preparation is the widely heralded Ehrlich's salvarsan ("606") or dioxydiamidoarsenobenzol. This remedy undoubtedly does give a decidedly alterative effect from a single intramuscular or intravenous injection. Its influence upon latent luetic lesions appears to be unquestioned. That it could not cure all cases and all conditions of syphilis in one treatment is to be expected; that its proper employment in the future will give good results as its possibilities and limitations become better understood is also unquestioned. How far the criticisms that seem to be supported by reports of untoward effects may prove to be well founded, and how many of the ill results that appear to have been occasioned by its use may be due to faulty technic is a matter that the future will undoubtedly settle. Many cases have been reported as receiving marked and immediate relief from symptoms when doses of 0.3 to 0.6 gram have been given by the intramuscular or intravenous routes, or a combination of the two.

Fordyce recommends the intravenous injection of "606," to be followed by mercurial injections for a period of from four to six weeks. At the expiration of this interval a second intravenous injection of salvarsan is given and followed by another similar period of mercurial treatment. After a rest of one month a Wassermann test is given, and if negative the serum reactions are made at intervals of several months; and as long as they remain negative no treatment is given. If at any time the Wassermann reaction becomes positive, the intravenous injection of salvarsan and the supplementary course of mercury are repeated.

Skill in the diagnosis of syphilitic manifestations is of the utmost importance to dentists and oral surgeons for their own protection and the welfare of their patients, both syphilitic and non-syphilitic. They may or may not undertake the treatment of these cases, but the menace of the presence of syphilis cannot be avoided except by care and intelligent understanding of the symptoms.

CHANCROID.

Chancroid or soft chancre is a specific local, contagious, autoinfectious venereal ulcer. Its nature is quite unlike the hard or syphilitic chancre with which it is sometimes confused.

Etiology.—Chancroid is caused by the streptobacillus of Ducrey, although it is often a mixed infection, and microscopic examination may show pyogenic and other bacteria. It is almost never acquired except in sexual intercourse. There must be an abrasion of the skin at the point of infection in order to transmit the affection, except in cases where many hours of constant contact make it possible.

Symptoms.—The lesion is local, and is not accompanied by systemic reaction or infection. After a single ulcer upon the male or female genitals others soon appear. These may spread by contact or extension to other regions. The anus, thighs, abdomen, or any other part of the body that the infection reaches may become infected.

The period of incubation is usually from three to five days. Occasionally it may be as long as ten days when actual infection is delayed.

Chancroid, when uncomplicated, is a round ulcer with sharply defined, often undermined and everted edges. It is surrounded by an inflamed base that is not indurated. In color it is grayish yellow, with abundant purulent secretion.

The Mixed Sore.—Much difficulty in diagnosis arises when chancroid and syphilis occur at the same time. The chancroid may be evident, and the syphilis not so much. The natural result of such a condition might easily be an error in diagnosis, with serious consequences.

Bubo.—Bubo follows chancroid, according to Keyes, in about one out of every three cases. This inflammatory condition of the inguinal glands may gradually disappear by resolution, or suppuration may take place. The pus from these *virulent buboes* is auto-inoculable.

Diagnosis.—Chancroid is diagnosticated by recognition of its bacillus with the microscope, and by auto-inoculation if the history and symptoms are not sufficiently clear. Its differentiation from chancre may be determined by the clinical features set forth in the table on page 117.

Prognosis.—Simple, uncomplicated chancroid is controlled with comparative ease. When, however, phagedena occurs through mixed streptococcus infection, the prognosis is less favorable, and cases have been reported with destruction of the urethra, followed by extension of the disease up the penis until the mucous membrane of the bladder was attacked, and death followed. Fortunately such cases are very rare.

Treatment.—Cauterization in the treatment of newly formed chancroids is useful if all the sores be thoroughly treated. Following the cauterizing agent, the sore is cleaned with dioxogen, and a soothing dressing applied.

Recently the tendency has been to treat chancroid as any other local infection would be treated, by the use of suitable bactericidal agent and mildly antiseptic dusting powder, without resort to cauterization by silver nitrate, nitric and carbolic acid, and similar agents. Effort should be made to prevent extension to the groin by keeping the patient quiet and making hot applications the moment inflammatory symptoms rein this gion are noted.

ACTINOMYCOSIS.

Actinomycosis is a chronic infectious disease, characterized by inflammatory reaction of the tissues, with a tendency to the formation of suppurative foci; it affects man and domestic animals, and is caused by the Streptothrix actinomycosis or ray fungus.

On account of the frequency with which cattle are affected by lumpy jaw, an attempt has been made to distinguish actinomycosis bovis from that which affects man; but this distinction does not seem to hold, as the organisms are practically identical.

Etiology.—Actinomyces are found upon oat seed, the rust-covered straws of wheat and other grains.

It has commonly been accepted that infection must occur through some such medium, but as the fungus is also found upon vegetable substances, it has been suggested that salads and uncooked vegetables may be responsible for infection.

The suggestion of recent writers, notably Stengel, that the organism is a rigid anaërobe and grows only at body temperature, tends to disprove these views. He says: "It is likely that the actinomyces is a normal inhabitant of the mouth and gastro-intestinal tract, and that it is always derived from these sources. Carious teeth and lesions of the mucous membranes play a part in the etiology."

The presence of portions of straw, the husk of grains, and similar substances that have been reported as being found within the suppurative foci of this disease, lend color to the former theory; while the great frequency with which the disease is found to have its beginning in the mouth and associated structures gives clinical support to the latter.

Coplin[1] states that studies of the last few years appear to have established that "actinomycosis may be due to any one of several closely related parasites."

Wright[2] and other investigators maintain that the independence of the true actinomyces has been established.

Pathology.—The actinomyces cause round-celled infiltration and proliferation in the connective tissues surrounding the parasite. This may lead on to softening, necrosis, and suppuration. In man the gums, cheeks, and floor of the mouth, as well as the lungs, intestines, and other internal organs, may be affected. There seems to be an alternate tendency to suppuration and repair, which is accompanied by cicatrization with marked induration of the tissues. In the jaw-bone there is progressive decalcification of the osseous structures, with tendency to the formation of nodular masses in the surrounding soft tissue. Metastases sometimes occur through penetration of the blood-vessels or lymph channels, and thus any organ of the body may become involved.

[1] Manual of Pathology, p. 167.

[2] Jour. Med. Research, May, 1905. Stengel: Text-book of Pathology, pp. 298, 299.

Symptoms.—As a rule, actinomycosis becomes chronic and continues over periods varying from months to years. According to Coplin,[1] in over 50 per cent. of the cases in man the lesion is located in the tissues of the head and neck. Poncet Berard suggested division of actinomycotic affections into four regions: (1) Cervical-facial; (2) thoracic; (3) abdominal; and (4) cutaneous. Its appearance in other regions, such as the brain, spinal column, genito-urinary tract, and in the various special organs is chiefly accepted as an indication of complications by metastatic extension.

When the face and the neck are affected the point of beginning usually appears in the vicinity of a diseased tooth. There is swelling upon the affected side over and around the jaw, sometimes including the adjacent glands of the neck. A number of fistulous openings

Fig. 59.—Fistulæ of actinomycosis.

often discharge from the point of suppuration (Fig. 59), and in long-standing cases these are surrounded by firm nodular masses (Fig. 60) which represent the sites of previous inflammatory foci. The characteristic discharge contains sulphur-like granules, which have sometimes been likened to mustard seeds in appearance. When these are spread upon a microscopic slide, the typical ray shape of the fungus becomes noticeable (Fig. 61).

Pain.—Pain may or may not be an important symptom. Many times the condition is practically painless. In other cases chronic pain may be complained of through pressure or involvement of nerve structures. Fever is seldom observed. In view of the often extensive

[1] Manual of Pathology, p. 169.

and serious character of the lesions, the general symptoms are comparatively slight if at all noticeable.

FIG. 60.—Actinomycosis of cheek, showing nodular masses. (Illich.)

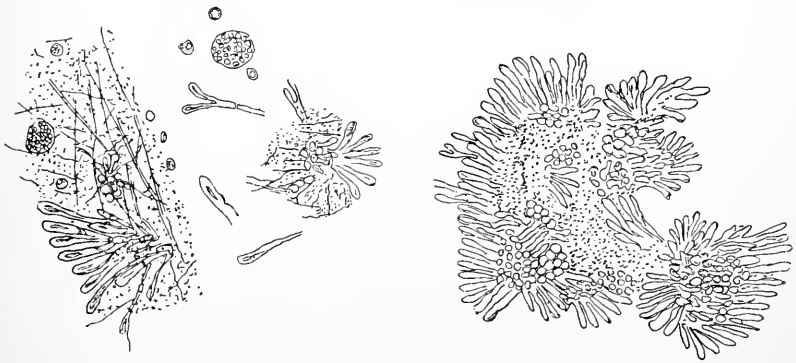


FIG. 61.—Actinomyces.

These symptoms are of course subject to complications such as may arise in the course of any inflammatory process.

Trismus.—Trismus is a quite common symptom in cases of actinomycosis which affect the jaws, because the inflammatory infiltration quickly involves the muscles of mastication. Even from the neck and cheek the masseter, temporal, and pterygoid muscles may be affected. As the disease extends, the hardened masses become fixed, and the difficulty of jaw movement is increased.

Diagnosis.—The description of the symptoms of actinomycosis might lead to the expectation that the disease would be easily recognized, but, as a matter of fact, clinical experience often demonstrates that there is much difficulty in differentiating its symptoms from those of a number of other affections. The swelling and extensive induration in the region of the malar bone and cheek, when fistulæ are absent, are sometimes not easily distinguished from malignant growths or even gumma. Of course, time will usually demonstrate the tendency to break down and the formation of pus; but time in dealing with neoplasms in that region is a matter of first importance. Microscopic sections of tissue in these cases must be made to complete differentiation. Sometimes the greater density of the actinomycotic mass and the history of the case may serve to give reasonable assurance of its character.

Necrosis of the jaws, chronic dento-alveolar abscesses, especially when there has been an extensive diffuse suppurative periostitis, or if a number of chronic dento-alveolar abscesses are involved, a series of fistulæ discharging through the neck and the induration from repeated acute inflammations, in chronic cases of long standing, may produce conditions the external appearance of which it is difficult to distinguish from actinomycosis. Tubercular affections in the same region are also occasionally of such character as to make their identification difficult, except by determining the presence of tubercle bacilli. If the yellow granules which so readily display the ray fungus were constantly present in the pus, the difficulty would not be so great; but they do not appear to be constant in the discharge at all stages; doubtless because there is so frequently a mixed infection in which the pathogenic microorganisms largely supersede the actinomyces, and under these conditions render difficult their recognition.

Widal[1] has applied the principles of his well-known agglutination test for typhoid to secure a similar reaction in actinomycosis, and to ascertain whether the spores of Sporotrichum beurmanni, which, in contact with serum from subjects with sporotrichosis, give rise to intense agglutinations at 1 to 400, 1 to 500, and over, might not also be agglutinated by the serum from individuals with actinomycosis (coagglutination).

"This hypothesis was verified in practice, 8 patients of different ages and with different types of actinomycosis, all exhibited manifest coagglutination on contact with the spores of the sporotrichum, varying

[1] Jour. de Chirurg., July, 1910.

from 1 to 50 to 1 to 51. Moreover, they all showed well-marked cofixation. When this phenomenon is obtained it shows we are dealing with a mycosis belonging to the same family as the actinomycosis; once this is established, the clinical course should enable actinomycosis to be differentiated from other mycoses caused by the same family."

Prognosis.—The prognosis is good when the foci of infection can be completely removed and the surrounding areas properly treated.

Treatment.—The surgical treatment consists of the removal of the diseased tissue as effectively as possible. The extensive resections of the jaw, which were formerly thought necessary, are now practically discarded. Removal of a portion of the jaw-bone and the thorough curettement of the diseased surface with a bone curette, as in cases of caries and necrosis of bone from other causes, is sufficient. The excision of the fistulous tracts and thorough destruction of the inflammatory foci, with removal of the indurated tissue masses, is found to be sufficient when supplemented by proper local internal treatment. Potassium iodide taken internally, and the direct application of iodin to the wound surfaces, formerly gave the most satisfactory results. Experiments of the Agricultural Department of the University of Wisconsin showed that when grains before planting were washed in sulphate of copper, there was freedom from rust. The same remedy was applied in the treatment of actinomycosis by Bevan, of Chicago, and others. The internal administration of sulphate of copper and its application directly to the lesion were found to give the most satisfactory results. This method of treatment was first reported to the dental profession by Dr. T. W. Brophy, of Chicago, with the description of some interesting cases and results.

A suggestion from the author's experience may perhaps simplify these cases to those unfamiliar with their appearance and treatment. The all-important differentiation of neoplasm by the microscope gives the operator a considerable measure of freedom. The use of potassium iodide internally and local applications of tincture of iodin would be beneficial rather than harmful, even though the disease chanced to be syphilis or even tuberculosis, and thorough surgical removal of diseased tissue ought to facilitate recovery in any one of several pathological affections with which this disease might probably be confused. Continued observation of the cases; examination of the contents of the fistulous tracts; microscopic study of the diseased tissue; the application of diagnostic methods which would be likely to lead to the detection or exclusion of other diseases if the symptoms of actinomycosis were not sufficiently positive to be depended upon; might one or all be relied upon for differentiation during the progress of the disease; and in the meantime the treatment would be helpful rather than harmful.

Stengel[1] describes a case of actinomycosis of the cheek, which is of

[1] Med. Record, June 4, 1910.

particular interest because of the definite recognition of its point of origin, as well as for his description of symptoms and treatment:

"A week later" (than the injury, which occurred November 1) "the patient felt a slight elevation and hardness at the spot of injury. His first impression of it was a swelling of the mouth of Steno's duct, such as occasionally occurs. The induration, however, remained and seemed to be increasing during the next three weeks. On December 3 the mother discovered a slight purplish spot on the outside of the cheek opposite the growth within, and on examination the whole cheek was found occupied by a resilient mass that seemed attached to the skin on the outside and the mucosa within. J. W. White advised incision on the inner side. At operation the mass was found to be uniform, pinkish, with no sign of breaking down within. Portions were found to be made up of round cells, which suggested an inflammatory process or sarcoma. No actinomyces were discovered. Though drainage with gauze was maintained on the inside, the growth extended out, and soon an abscess-like projection formed at the side of the purplish area. The danger of extensive involvement of the skin now led to an incision where the growth pointed externally. A small amount of broken-down yellowish material was obtained and portions of the growth were removed. In the latter, after a number of sections were studied, actinomyces were detected. The patient had in the meantime been given increasing doses of KI on account of the suspicions of actinomycosis after the first appearance of the purplish discoloration and external projection. Another abscess-like formation developed on January 15, and was opened January 18. Increasing doses of KI, up to 60 grains daily, were given without materially influencing the progress. At this time, on the suggestion of A. C. Wood, diluted tincture of iodin was used in each of the incisions or sinuses. Almost immediately there was a manifest improvement, and within a fortnight the whole infiltration had resolved. Subsequently the incisions healed. The patient never suffered any recurrence, and is now in good health."

GLANDERS.

Glanders is an infectious and contagious disease due to a specific bacillus, which chiefly affects horses and asses, though it may be communicated to other animals and to man.

Etiology.—Glanders infection is caused by the Bacillus mallei. When involving only the skin and adjacent glands it is called farcy. When the mucous membrane is affected, the condition is termed glanders. Usually it is communicated to man from the horse, although it affects a considerable variety of domestic and wild animals. The bacilli commonly gain entrance through some abraded or wounded surface in the skin or mucous membrane.

Pathology.—It first appears in the form of a small nodule which contains the almost pure leukocytic infiltrate, a few giant cells, and the characteristic bacilli. This increases and produces an ulcer, which

usually results in a series of ulcers that may or may not become confluent. Extension through the lymphatic system sometimes leads to a chronic condition. In acute cases multiple abscesses throughout the body may cause death from exhaustion and toxemia.

Symptoms.—Glanders may be acute or chronic. Farcy also appears in both acute and chronic forms, although according to some authorities farcy is applied to a chronic form of this affection; but this somewhat arbitrary classification does not seem to be borne out by clinical manifestations.

In *acute glanders* there is a period of incubation of approximately three or four days. Two recorded cases, in which the symptoms appeared in six days and six weeks respectively, serve to show the wide limits within which the incubation period varies.

Swelling, redness, and the usual signs of lymphatic involvement appear at the point of inoculation. The mucous membranes of the nose are attacked in the course of a few days. When the nodules which form there break down there is a discharge of mucopus. The nose and lymph nodes of the neck may become considerably swollen, and there is usually an eruption of papules and pustules upon the face.

The duration of the disease is about ten days, and it terminates fatally, usually from involvement of the lungs.

In *chronic glanders* the chief symptoms are those of chronic nasal catarrh, with ulcers upon the surface of the mucous membrane.

In *acute farcy* the skin is affected by intense local inflammation. Nodules called farcy buds are felt along the course of the lymphatics, because of their involvement. Suppuration may ensue as with other lymphatic affections. Papular eruption sometimes appears upon the skin. Fever occurs, resembling that of typhoid or septic infection. Pains and swelling in the joints are often a marked feature. Prognosis in these cases is almost as discouraging as that of acute glanders, death usually ensuing in the course of two weeks.

In *chronic farcy* the lymphatics are not specially involved; but nodular tumors form in the extremities. These may break down and give rise to abscesses or ulcers.

Diagnosis.—One method of diagnosis is made by the peritoneal inoculation of male guinea-pigs with the suspected discharges according to Strauss' test. If the Bacilli mallei are present there will be swelling of the testes, followed by swelling and ulceration of the scrotum before the fifth or sixth day.

Mallein is prepared from the bacilli and used for diagnostic purposes in the same manner as tuberculin for tuberculosis.[1]

The Agglutination Test.—This procedure for the diagnosis of glanders is based upon the phenomena of agglutination and precipitation. When the blood serum of a horse affected with glanders is brought into contact with certain cultures of either live or dead bacteria, which are the specific cause of the disease, a clumping or formation

[1] Coplin: Manual of Pathology, p. 161.

of the flocculent masses of the organisms will take place. The glanders germs which before the addition of glandular horse serum are scattered singly through the liquid, when placed under the influence of glandular serum become so changed that they gradually adhere one to another and form small flakes, which settle at the bottom of the container, or, in other words, precipitate. These bacteria are taken from the culture, killed by heating, and placed in suspension in a germicidal or preserving fluid, thus forming an emulsion or suspension of dead glandular germs. To a given amount of this suspension of glandular organisms, or test fluid, given amounts of glandular horse serum are added. Serum from an animal affected with glanders causes the dead suspended germs to agglutinate or clump, and flocculent masses of the dead germs are formed throughout the suspension fluid. This is called a positive reaction. When the reaction or agglutination is complete, the flocculent masses of agglutinated bacteria will have settled at the bottom of the tube.

To facilitate making this test the department of experimental medicine of the Parke-Davis Laboratory has devised a simplified apparatus, with control tubes, containing the test fluid to which no serum has been added; and other tubes which contains respectively 1 part of serum to 200, 500, 800, and 1200 parts of test fluid.

The conclusions from these tests are that all horses whose blood agglutinates in solutions of 1 to 1000 or higher should be destroyed; all those that show agglutination as low as 1 to 500, if they show symptoms of glanders, should be destroyed; below that they may be considered safe.

Bernstein and Carling[1] refer to 5 cases of glanders that were admitted to the Westminster Hospital in London, and state that reports which show glanders to be a rare affection are misleading. They hold that it is much more common than is generally supposed, so much so that "whenever there is a chronic inflammatory lesion of the oral or nasal mucosa, or an inflammatory mass in the subcutaneous or muscular tissue, if it is known that the patient has been brought into contact with sick horses, the diagnostician should be on the alert for glanders."

Treatment.—If seen early, cauterization or excision of the lesion may be helpful. The enlarged glands or farcy buds may be opened and disinfected.

Beyond measures of this character and treatment to relieve the symptoms there seem to be no known satisfactory therapeutic methods with which to combat this disease.

ANTHRAX, WOOLSORTERS' DISEASE, MALIGNANT PUSTULE, SPLENIC FEVER.

Anthrax is an acute infectious disease, which, although other animals may be affected, attacks sheep and cattle most frequently, and from

[1] British Med. Jour., February 6, 1909.

these is often communicated directly or indirectly to man. Dogs, cats, birds, and cold-blooded animals appear to be quite immune.

Etiology.—It is caused by anthrax bacillus, a more than ordinarily resistant, readily spore-forming bacillus. These bacilli will withstand a boiling temperature of water for several minutes; to destroy them requires prolonged immersion in a solution as strong as 5 per cent. carbolic acid; they are not killed by the gastric juices, and the spores are believed to be capable of living for a long period of time outside of the body. Those who handle hides are frequently infected on the hands and face, as are butchers, through contaminated meat, and woolsorters by inhalation of infection.

Symptoms.—A swelling develops at the site of the infection, which is intensely inflammatory, surrounded by slight bullous vesicles and usually attended with considerable edema. A sanious liquid is discharged when erosion of the surface takes place, and there may be more or less pus formation. Bacilli are found in all of the local lesions and are eventually carried into the blood, and thus reach the spleen, liver, kidneys, lungs, and other organs. They are also discharged from the body in the stools and urine, and thus give opportunity for the infection of other animals. Infection through the gastro-intestinal tract causes hemorrhagic extravasation, ulceration of the mucous surfaces, and profuse diarrhea with bloody discharges.

The postules which form on the hands, arms, face, and neck in the *external* variety of this disease usually follow an incubation period of two or three days. The characteristic malignant anthrax edema in many cases follows in the course of a few hours. Death sometimes occurs within three or four days.

Intestinal anthrax is ushered in by a chill, followed by diarrhea, fever, and other evidences of acute infection.

The disease in the *respiratory tract* is accompanied by severe symptoms, of which chills, pains in the chest, back, and legs, respiratory difficulties, fever, and cough are marked indications. Death sometimes occurs within thirty-six hours of the onset of the disease.

Brewer[1] reports the mortality in cases in which infection has occurred in the extremities at less than 5 per cent., but when the lesion is on the neck or face the mortality rises to about 30 per cent., with a much higher mortality in the internal cases.

Diagnosis.—Although the symptoms may sometimes be confusing, the diagnosis is readily made by recognition of the bacillus.

Prognosis.—In cases of external anthrax the mortality does not usually exceed 5 per cent. When the lesion is situated on the neck or face the death-rate is about 30 per cent.; in internal anthrax it is much higher.

Treatment.—Wide excision of the primary lesion should be made without an instant's avoidable delay. Adjacent lymph nodes that

[1] Text-book of Surgery, 3d ed., 1915, p. 48.

may be involved should also be removed, and the wound disinfected by some powerful germicide. Cauterization is sometimes effective, but not so much so as excision. The advocates of less radical methods urge that the cauterization is equally effective, and that it does not give opportunity for fatal general infection, which they believe is likely to follow in malignant cases when the bloodvessels are opened up by the incisions. Defects of the lips which are sometimes occasioned by the scars of these lesions may be remedied, if necessary, by plastic operations after recovery is complete. In other respects the disease should be treated as a toxemia, and all the natural forces should be stimulated by activity and nourished to the highest possible degree, to increase resistanee to infection.

The following table by Royer and Holmes[1] gives a comprehensive description of the manner of infection, and the results of treatment:

Occupation.	Location of lesion.	Day of disease.	Treatment.	Results.
Farmer	Forearm (left)	Eighth	Surgical and phenol injection	Cured.
Hide sorter	Right neck	Third	Serum only	Died.
Hide scraper	Right ring finger	Fourteenth	Local antiseptic	Cured.
Teamster	Right forearm	Third	Surgical and antiseptic	Died.
Morocco worker	Neck (left)	Fifth	Serum and surgical	Cured.
Hair sorter	Left neck	Third	Serum and surgical	Cured.
Hide sorter	Lower lip (right)	Fifth	Surgical	Cured.
Hide stacker	Forehead (right)	Twelfth	Serum and surgical	Cured.
Hide stacker	Face (left side)	Twenty-first	Serum only	Cured.
Stevedore	Neck (left)	Fourth	Serum and late surgical	Died.
Hair sorter	Neck (right)	Fourth	Serum only	Cured.
Hair washer	Right cheek	Fourth	Serum only	Cured.
Hair comber	Right cheek	Fifth	Serum and surgical	Cured.
Clerk and hair dealer	Chin (left side)	Third	Serum and surgical	Cured.
Hair spinner	Right cheek	Second	Serum and surgical	Cured.

The conclusions of these authors with regard to treatment are also of interest:

"Only general conclusions regarding the treatment may be drawn from these cases, and these chiefly from individual cases. Serum treatment alone in certain cases seems to be curative. Serum combined with excision and cauterization with bichloride would seem to give best results in severe cases, while excision and cauterization will undoubtedly cure many."

Two cases reported by Clarke[2] illustrate important features. These "occurred simultaneously in a farmer and a butcher's assistant respectively, who had four days previously killed and dressed a diseased bull, apparently neither having the least idea of the cause of the animal's illness. Four days after each noticed a pimple on his arm.

"The farmer, aged twenty-eight years, called with a sore. The site

[1] Therap. Gaz., January, 1908.
[2] Lancet, February 29, 1908.

was the upper antero-external surface of the left forearm; it was about one inch in diameter, with a depressed center and a ring of low vesicles around; the central depression was purplish red but not black—it could not have been described as a typical pustule. There was no edema and no pain. The axillary glands were enlarged. The temperature was 100.4° F., and he complained of frontal headache; his tongue was furred and there was some general constitutional disturbance. This patient had attempted no local treatment. Slides were promptly prepared from the vesicles and stained. A few large bacilli were seen, occurring singly and in chains. That night the pustule was excised with a margin of sound skin, the subjacent fatty tissue being removed at the same time; pure carbolic was then applied and the wound dressed with sal alembroth gauze soaked in bichloride lotion.

"In Case 2 the lesion was on the back of the wrist and was only the size of a dime. The pustule was far more typical; there was a dark central eschar. There had been considerable pain in the sore, coming on a day or so after he first noticed the pimple, which had led the patient to poultice it. He had no constitutional symptoms and had continued at his work. When seen the wrist was slightly edematous and there was some redness around the sore; the axillary glands were enlarged. In this case the pustule was drawn forward and frozen with ethyl chloride; its base transfixed and the sore was excised. The after-treatment was the same. Both healed up well."

LEPROSY, LEPRA, ELEPHANTIASIS GRECORUM.

This is a chronic infectious disease caused by the Bacillus lepræ.

Etiology.—The bacillus of leprosy, recognized as the cause of the disease, has been demonstrated in the blood, in the leprous lesions, and in the nasal mucus, without regard to the presence or absence of ulcerative conditions in the nose.

The disease has been transmitted to a condemned criminal by direct inoculation, and there has been much experimentation without absolutely definite results in the direction of attempting to inoculate animals with leprous tissue.

How far the conditions of countries and localities may influence the frequency of the disease, and whether fish or certain other articles of diet, to which attention has been called, may be regarded as factors in causation or predisposition, is not clear at the present time. Intimate association for a considerable period seems to be necessary to transmit the disease. It is believed to be hereditary, but whether it is the disease or the predisposition that is inherited is still a matter of doubt.

Symptoms.—It appears in two forms, the tubercular and the anesthetic.

In the tubercular form are found the characteristic skin lesions which appear in the early stages, and which have a reddish color,

with slight inflammatory reaction in the beginning. The latter lose the redness of color, and as the disease progresses may show tendency to break down and form ulcerations which heal slowly or become converted into fibrous, cicatricial masses that cause marked and unsightly deformities. The mucous membranes and internal organs may also be involved.

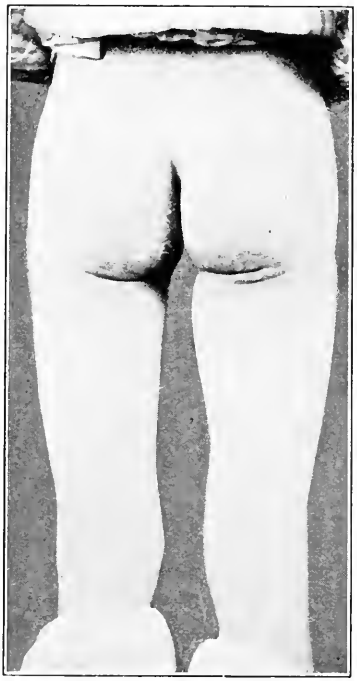


FIG. 62

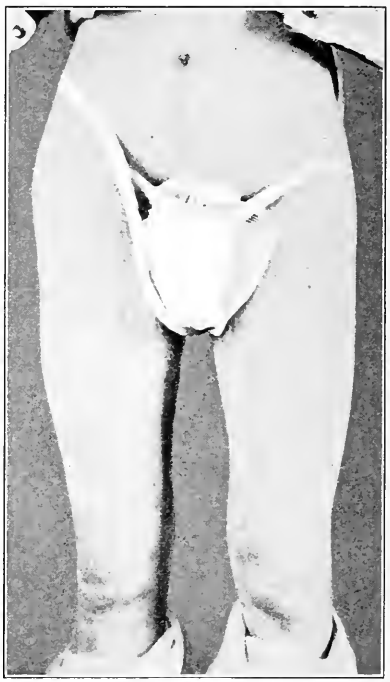


FIG. 63

FIG. 62.—Case I. Leprosy of the anesthetic type. Man, aged nineteen years, a Greek, who had been in this country about four years. The lesions were on the flexors and extensors of the thighs, the buttock, the flexors, and extensors of the forearms and elbows. Diagnosis was made by incision into an anesthetic patch over the left elbow, and this smear showed lepra bacilli in the blood. (Dr. Daniel Hopkinson and Dr. E. L. Tharinger.)

FIG. 63.—Same man shown in Case I, Fig. 62.

In the anesthetic form, hyperesthesia and neuralgia pains and ulcerations due to trophic changes are notable features.

Discolored spots appear upon the skin surface, and these may be followed by ulcerations. Both forms may be found together. Secondary infection may lead to ulceration and gangrene, with extensive destruction of tissue—the so-called lepra mutilans or lepra gangrenosa.

These cases were rarely met with in this country, and there was much confusion with regard to both diagnosis and treatment. In recent years many cases have been discovered in the Central States, as,

FIG. 64.—Lepra bacilli. Smear from incised nodule. From case illustrated in Fig. 62.

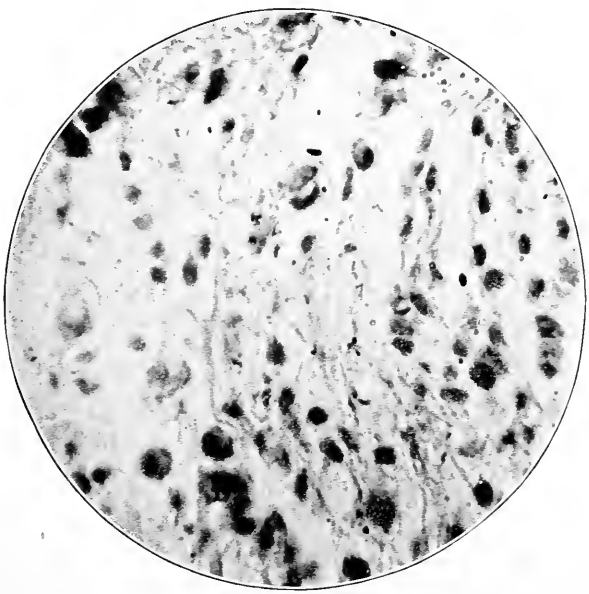


FIG. 65.—Lepra nodule containing lepra bacilli. From case illustrated in Fig. 66.

for example, the two in Milwaukee, illustrations of which are shown in Figs. 62 to 66. Nevertheless the interest they may have for the oral surgeon is largely academic, and a more extended description of cases would therefore seem to be unnecessary.

FIG. 66

FIG. 67

FIG. 66.—Case II. Nodular type of leprosy. Subject was a Greek, aged twenty-three years, in this country about six years; has had the lesions about eight months. Nodules distributed over face, hands, and extremities. He had a rhinitis for about three months, when the lesions first appeared. The nodules developed in considerable numbers and then receded. Diagnosis was made by excising a nodule in the forearm. The blood smear showed typical lepra bacilli, as illustrated in Figs. 64 and 65. It is significant that both of these men appeared to have contracted the disease in this country, unless the inoculation period is really much longer than is generally believed. (Dr. Daniel Hopkinson and Dr. E. L. Tharinger.)

FIG. 67.—Same patient as in Case II, Fig. 66.

FOCAL INFECTION OF ORAL ORIGIN.

For clinical purposes it seems best to group for consideration in this relation some affections of the oral cavity that might otherwise have been described in other chapters, with their several pathological classifications.

Since Rosenow brought to light the theory of the transmutation of microörganisms in 1913, the etiological and pathological importance of the diseases of the teeth and other oral structures has been greatly emphasized. All investigators do not entirely agree with Rosenow's

findings, but the vast amount of clinical data recorded with reference to diseases of the mouth and dental organs that seem to bear a vital relation to general and remote local affections, leans so strongly in this direction that the more or less technical character of the objections that have been raised fall naturally to the background of secondary consideration. As is usual under such circumstances the pendulum of methods of practice immediately swung from one extreme far over to the opposite one, and the sacrifice of teeth at once became the price of insufficient general diagnosis. When the real cause of a pathological condition situated in almost any part of the body, and of almost any character, was not very clear, in many instances every tooth that was not like "Caesar's wife" was summarily extracted. The natural result is that many people have fewer teeth, and often suffer great disadvantage from this cause, but they still have their original pathological affections. On the other hand, there can be no doubt of the inestimable importance of diseases of the mouth and the therapeutic value of proper disposal of these foci of infection.

According to Billings the recognition and removal of the focus is imperative as a fundamental principle to stop the progression of ill health.

Rosenow[1] gives the following conclusions:

"The experiments on mutation show that when these and other streptococci are grown in symbiosis with other bacteria, and under a low oxygen pressure, they may acquire new features, and that sometimes they undergo marked changes on passage through animals. The places in the human body where such conditions prevail, and where special features are likely to be acquired, are parts of infection such as in the tonsils, various sinuses, the appendix, and about the gums and teeth.

"The strains from muscular rheumatism, especially after one or two animal passages, as well as other streptococci when they have attained a similar grade of virulence, show a marked affinity for the mucous membrane of the stomach, the pelvic mucous membrane and medullary portion of the kidney and the gall-bladder. Ulcer of the stomach, the picture of an 'ascending' nephritis, cholecystitis with beginning formation of gall-stones, caused by streptococci, have been found repeatedly in rabbits and dogs injected with strains, especially after one or more animal passages.

"The essential element in favor of the mutation of pathogenic microörganisms in the human body is that the foci may be suitable for their long continuance of these situations.

"Obviously then acute inflammatory conditions, the cardinal symptoms of which demand more or less immediate relief, or abscesses in which a sinus gives an exit to the pus, distressing or even alarming as these often appear to be, are not, as a rule, the affections that are of most serious etiological importance.

[1] Jour. Infect. Dis., January, 1914.

"Hence the comparative general limitation of acute diseases of the periosteal, osseous, or other tissues of the mouth as causative factors to the effects of acute infections. It is the so-called blind abscesses, the granulomata, which seldom give rise to noticeable symptoms that favor the continuance of bacteria in these foci, which gradually increase in size as surrounding bone absorption takes place, that may so often be held accountable for remote chronic diseased conditions. Many authorities now agree that focal infections of this character may have an important relation to cases of rheumatoid arthritis, iritis, endocarditis, myocarditis, ulcer of the stomach, disease of the kidneys, or anemia, leukemia, and other affections manifesting themselves through blood disturbances; chorea and many similar disorders of almost unlimited extent, or pathological manifestations touching the brain, spinal cord and nerve structures in which infection may play a part." (See Fig. 70.)

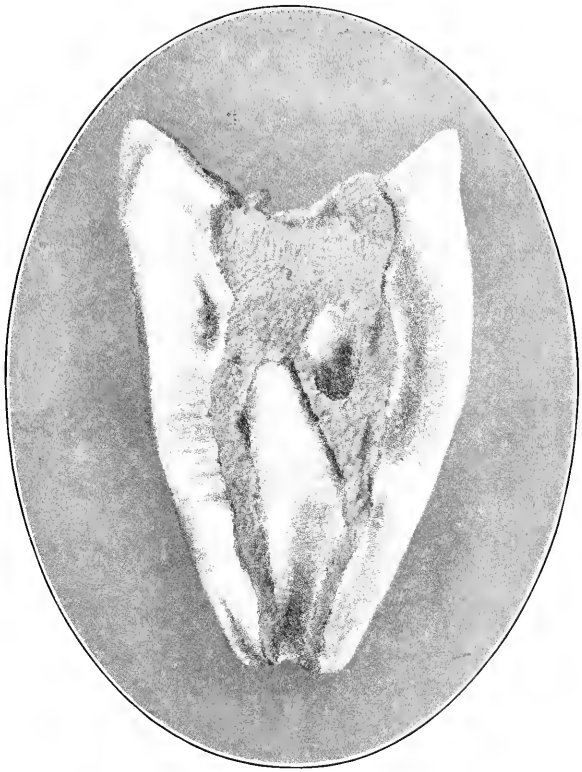
Hebble has presented, in an article in the *Dental Summary*, some facts and figures gleaned from the work of important writers which give an adequate idea of the general pathological relation of oral infectious foci.

"According to Irons[1] an unselected group of 329 patients in a ward in Cook County Hospital, Chicago, was studied and the relations of all discoverable infectious processes tabulated for each patient. The patients were then classified, according to final diagnosis, and the percentage of each type of infection in each group calculated. Roentgen-ray studies, most of which were confirmed by consultation with dental surgeons, were obtained of 124 of the 329 patients. In 44 per cent. of the 124 patients alveolar abscesses were found. In the arthritic group 76 per cent. had alveolar abscesses. In the group of nephritis and cardiovascular disease, 47 per cent.; other diseases, including pneumonias, 23 per cent., or less than one-third of the percentage in the arthritic group. Abnormalities in tonsils as expressed by hypertrophy were present in 45 per cent. of the arthritic groups, in 24 per cent. of the cardiovascular group, and in 19 per cent. of the remainder. Other chronic infections, such as those of sinuses or genito-urinary tract, were found in 21 per cent. of the arthritic group, 13 per cent. in the cardiovascular group, and 11 per cent. of the other diseases. Syphilis, either from the history, clinical evidence, or Wassermann, was found in 23 per cent. of the arthritic group, 39 per cent. of the cardiovascular group, and 13 per cent. of other diseases.

"In experiments conducted at the University of Minnesota Hospital by Ulrich[2] a little over 61 per cent. of all artificially devitalized teeth were found with apical abscesses, and the total number of abscesses on 1350 teeth, including those found on non-vital teeth due to caries or trauma, was 83 per cent. One hundred and fifty-nine of these cases had bacteriological review. Henrici reported 107 cases from the university clinic, of which 100 gave the Streptococcus viridans; 52 were

[1] Jour. Am. Med. Assn., September 16, 1916.
[2] Ibid., November, 1915.

PLATE IV



Dentin Impregnated with Rosin-chloropercha Solution.
(Callahan.)

PLATE V

A

Illustration of a Section of a Tooth with the Dental Tubuli Stained by Injection of the Tooth Pulp. A Rare Result Accomplished by Dr. V. A. Latham, of Chicago.

B

Illustration of a Section of a Tooth with the Dentinal Tubuli Stained by Injection of the Dental Pulp. It also Shows the Result of a Pericemental Abscess. (Dr. V. A. Latham.)

from the private clinic of Ulrich, 50 of which gave Streptococcus viridans or Streptococcus hemolyticus. Occasionally Streptococcus mucosa was recovered. Thus of 500 cases examined 150 gave evidence of streptococcus either in pure culture or as the dominant organism. Occasionally the Staphylococcus aureus or albus or the Micrococcus catarrhalis was also observed in conjunction with streptococcus. Gilmer and Moody[1] report streptococci, both Streptococcus viridans and Streptococcus hemolyticus, as well as other organisms, such as Staphylococcus aureus, Micrococcus catarrhalis, the Bacillus fusiformis, and in two instances diphtheroid bacilli. Hartzell and

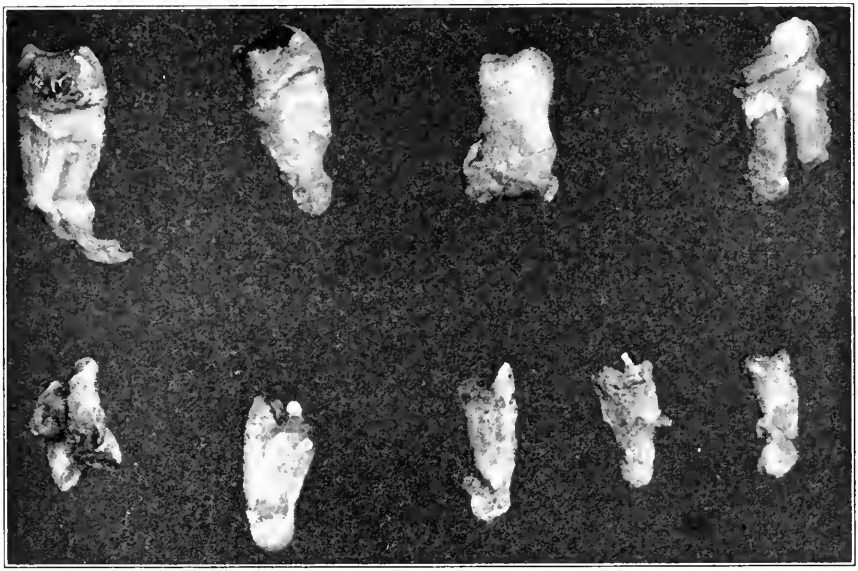


FIG. 68.—Alveolar abscessed teeth showing granulomatous and other ill effects of dento-alveolar abscess upon the roots of teeth and the hopelessness of endeavoring to save roots of this character. (Latham.)

Henrici[2] found in 162 cases that 150 yielded streptococci. They report inoculation of 24 rabbits with Streptococcus viridans isolated from apical abscesses, with the following results: heart lesions were found in 5, kidney lesions in 7, those of the aorta in 3, and of joints 2.

"By actual weight and count Kligler[3] has shown that human tooth scrapings from healthy mouths contain from 6,000,000 to 8,000,000 bacteria to the milligram. By weight and count he has shown that 44 per cent. of this enormous mass of bacteria is streptococci and from 18 per cent. to 22 per cent. is staphylococci."

[1] Jour. Am. Med. Assn., December 5, 1914.
[2] Ibid., March, 1915.
[3] Jour. Allied Societies, September, 1915.

DENTO-ALVEOLAR ABSCESSES.

For clinical as well as pathological reasons it is necessary to distinguish between dento-alveolar apical abscesses in which there is an accumulation of pus surrounding or associated with the apical end of the root of a devitalized tooth and pericemental abscesses which may occur in connection with the roots of teeth having vital pulps.

Etiology.—A tooth pulp may become devitalized through its exposure in the course of dental caries, whereby it is subjected to irritation by the secretions of the mouth, bacterial invasion and other vicious influences. Severe traumatic injury may destroy the integrity of the bloodvessels and nerves as they enter the apical foramina and thus cause loss of vitality in the tooth pulps. This may also occur from severe pericemental inflammation or infection in this region. Septic agents are then forced through the apex of the root by the confined gases within the pulp chamber of the tooth, and thus infection of the alveolar structures surrounding the apex of the root results in due course in the formation of a typical abscess at that point. This may extend until the pus finds an exit through a fistulous opening in the mouth, or failing this, becomes what is known as a blind abscess, or the pus may find its way through channels of bone until it reaches some more distant point of exit, such as the maxillary sinus or the nasal cavity. The so-called blind abscess, the granuloma, with its protective wall in the form of an enclosing fibrous sac, containing lymphocytes and leukocytes, is apparently partly due to proliferation of the pericementum in response to chronic inflammation and also to the usual lymph protection thrown out in the course of abscess formation.

Diagnosis.—In discovering the existence of these foci no other agent is so useful as the *x*-rays. Radiographs such as in Figs. 69 and 70 usually show quite distinctly the dark areas surrounding the affected portion of the root. The essential feature in testing the teeth is to determine if the pulp be vital. This may be accomplished by the aid of the interrupted current, or the application of heat or cold to determine the sensitiveness to thermal changes, will often lead in the direction of the discovery of these foci.

Treatment.—The author does not hold with Rosenow that every devitalized tooth root is necessarily a menace because the tubuli of the dentin may harbor microörganisms even though the root canal be completely filled. He does believe that once septic conditions have taken place within the pulp chamber of the tooth that it is not only necessary to have the root canal properly filled to the apex with gutta-percha or some equally suitable root-filling material, but that it is also in the highest degree necessary that the dentinal tubuli should be sealed according to the Callahan or some equally effective method. Figs. 71 and 72 illustrate the importance of this statement. It can only be determined that this has been successfully accomplished by

taking other radiograms to show the actual condition of the root after it has been filled.

Exsection of the Roots of Teeth.—The amputation of the apical end of the root of a tooth, the so-called apiectomy, is very generally practised among dentists. In some cases this treatment is warranted and

FIG. 69

FIG. 70

FIG. 69.—Dento-alveolar abscess associated with pernicious anemia.

FIG. 70.—Defective root fillings from the mouth of a business man with extensive interests, who broke down so completely that he was obliged to give up work and withdraw from active participation in the direction of the institutions with which he was connected. Travel abroad, trips to Carlsbad and other watering places, with consultation by prominent internists in this country and Europe gave no relief and no definite diagnosis. Urinalyses and blood examinations gave every evidence of diseased conditions, but no light as to the cause. Complete recovery followed the treatment and extraction of several diseased teeth.

many useful dental organs have thus been preserved without prejudice to general health; on the other hand. the indiscriminate application of this method may occasionally result in the retention of a focus of infection of somewhat more serious character than before treatment. Very careful discrimination is necessary to determine in serious cases

FIG. 71

FIG. 72

FIG. 71.—Large dento-alveolar abscess associated with a devitalized gangrenous pulp in the lateral incisor, the root of which was not filled, and imperfectly filled root canals in the first bicuspid and central incisor teeth. In this case the maxillary sinus was also involved.

FIG. 72.—Dento-alveolar abscess and bone destruction due to pyorrhea alveolaris. The maxillary sinus was involved in this case.

whether the root should be extracted or retained through the assistance of this type of operative treatment. No matter what individual opinion might dictate it is only safe to prove the result by a radiographic picture after sufficient time has elapsed to permit the obliteration of the cavity in the bone by new tissue formation. If this is found

to be the case one year or longer after the operation, and the original symptoms of focal infection seem to have permanently disappeared, then the retention of the root is warranted, otherwise the grave pathological possibilities for which such a condition may be responsible are too great to weigh in the balance against the retention or loss of one or even all the teeth. What is true of dento-alveolar abscesses as a menace to general health, is also true in regard to roots of teeth affected by pyorrhea alveolaris. In these cases it is sometimes difficult to determine whether the pyorrhea is the result of some kidney or other affection or if the nephritic disease be the direct result of the effect of the oral condition. It is safe, however, to say that under all circumstances every effort should be made to completely eradicate the mouth disease. If this can be done safely by keeping the progress of the pyorrhea sufficiently in check to prevent continuance of infection from that region then such teeth may be safely retained; if not, then

FIG. 73

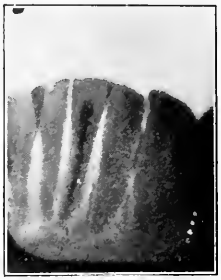


FIG. 74

FIG. 73.—Radiogram showing the result of a dento-alveolar abscess. In this case there was an acute arthritic affection of the left shoulder, severe long-continued headache and progressive loss of vision. All these symptoms were relieved after surgical treatment of the diseased area, and proper filling of the root canals of the affected teeth.

FIG. 74.—Radiogram taken approximately one year after the one shown in Fig. 73 for the same patient. Bone regeneration in the diseased area is evident.

the removal of the dental organs is the only safe procedure. It must be remembered that once the pericementum is destroyed from a root surface it has never been successfully proved that this membrane would regenerate sufficiently to again cover that surface perfectly, whether it be an area of denuded root surface at the apical portion from a dento-alveolar abscess or upon some aspect of the side of the root from pyorrhea alveolaris. In either case there will be predisposition to the continuance of the focus of infection unless this can be surgically obliterated.

The occasional necessity of recognizing an association of chronic affections and giving relief through complete obliteration of other factors as well as those concerning the teeth is illustrated in Fig. 73.

The author has given the following rules for the guidance of physicians and surgeons and dentists in his article in Ochsner's *Surgery:*

"1. It must be admitted that the value of a tooth or teeth cannot

be allowed to weigh in the balance against the reasonable possibility of serious general affections. Extraction should therefore be insisted upon unless complete security in this respect can be given by the treatment of the roots of such teeth.

"2. If an attempt be made to treat the root canals of suspicious teeth under these circumstances the sealing of the tubuli according to the Callahan or some similar method should be insisted upon.

FIG. 75.—Illustration of the case of a young girl who had for some time been bedridden with arthritis. Vaccines and other methods of treatment had been tried without avail. Her mouth and teeth were put in order at the clinic of the Southern Dental College and maxillary separation to widen her nose and give better drainage to the nasal accessory sinuses was performed under the direction of Dr. S. W. Foster, of Atlanta. The result was complete recovery. At the last report, a year or more after treatment, she was able to wear a No. 3 instead of a No. 5 shoe, and was able to run up stairs as well as anybody.

"3. There should not be only radiograms to show the condition before treatment, but immediately after also to prove that the root filling has reached the apical end of the root. If the root-canal filling is imperfect it should be made perfect or the tooth extracted.

"4. After a sufficient interval has elapsed another radiogram should be taken if necessary to demonstrate beyond the question of a doubt that there has been complete regeneration of the bone and pericemental

structures surrounding the end of the root, with total obliteration of the abscess. With such care many teeth could undoubtedly be saved with safety. Without such precaution the only safe procedure is to extract the teeth in order to remove the risk of continuation of the disease.

"5. It must not be forgotten that in many instances the indiscriminate extraction of teeth to relieve remote affections in the absence of complete diagnosis for the exclusion of other causes is a doubtful endeavor to relieve present ills with almost certain invitation of future

FIG. 76.—This girl is the subject of the illustration of arthritis in Fig. 75. The narrow appearance of the nose is important.

disturbance. The extraction of even one tooth from a perfect dental arch paves the way for malocclusion which may lead to pyorrhea alveolaris or some similar affection in the future. The loss of a number of teeth destroys the functional activity of the jaws and may make itself felt in the disarrangement of the digestive tract at some later period. Moreover, the effect upon metabolism of proper or improper mastication of food is one that cannot lightly be overlooked."

With the foregoing rules for guidance much may be done with safety for the simultaneous relief of focal infections and tooth preservation.

CHAPTER IV.

DISEASES OF THE MUCOUS MEMBRANE OF THE MOUTH.

STOMATITIS.

Inflammation of the mucous membrane of the mouth. This term is used to include all inflammatory conditions affecting the mucous surfaces of the gums, cheeks, lips, and tongue.

Marginal Gingivitis.—Marginal gingivitis is for clinical purposes assumed to be a slight inflammatory condition apparently confined to the border of the gums at the necks of the teeth.

Etiology.—It may be evidence of some general condition of disturbed digestive or other function; most frequently it is caused by uncleanliness, favoring the collection of food particles, bacteria, and salivary calculus in this region.

Symptoms.—The gum margins are red and inflamed, and may also become more or less everted.

Treatment.—The treatment consists in the restoration of healthful conditions by cleaning and scaling the teeth, the removal of any local irritant that may be a factor, and the application of tincture of iodin to the inflamed gum borders.

Interstitial Gingivitis.—The term interstitial gingivitis includes not only the gum borders, but the interstitial tissues as well, and involves all the alveolar structures, including the pericementum, connective tissue, gums, and bone. Talbot, who introduced this term, designed it to include all of a considerable variety of terms which technically represent different stages of the same disease, although by adoption they are accepted in a more general sense. Examples of these are: Calcic pericementitis, phagedenic pericementitis, pyorrhea alveolaris, Rigg's disease, chronic alveolitis, etc.

Etiology.—Its causes are predisposing and exciting, local and general, or constitutional.

Talbot holds that on account of the transitory nature of the alveolar structures there is a natural predisposition to their early absorption. For this reason and because of the peculiar nature of the circulatory conditions in this region they are unusually susceptible to all constitutional toxic influences. Therefore the effect of the administration of mercury, lead, iodin, and other poisons of similar nature gives early manifestation at the gum margins, and in like manner these structures are influenced by auto-intoxication from gastro-intestinal leukomains and toxemias; from acute infectious diseases as well as faulty metab-

olism due to chronic nutritional disturbances; organic affections leading to diseased conditions of the blood, and disorders of the central nerve system. Indican, the product of indol, resulting from intestinal fermentation, Talbot has shown to be almost constantly in excess in the urine of patients suffering from this affection, as is also acidosis evidenced by excess acidity above 40 per cent., or acidity below 30 per cent., an indication of insufficiency of renal elimination.

Symptoms.—Cases of interstitial gingivitis, in which the symptoms are chiefly confined to the roots of the teeth and the structures immediately surrounding them, are successfully treated by dentists, although they usually require constitutional treatment, that should be directed toward the cure of the underlying causes, and do not demand consideration from a surgical point of view. When, however, such conditions menace and involve adjacent bone and soft tissues extensively, they may lead to serious pathological nervous conditions of quite general nature by reason of the continued irritation of the loosened teeth. Disturbance of the digestive tract may be brought about through insufficient mastication and insalivation, or through swallowing pyogenic microorganisms which sometimes seriously affect the stomach and intestine. Extensive necrosis of the jaws or infectious conditions may penetrate the cavities of the nose or maxillary antra, affect the glands of the lymphatic system and the salivary glands, or lead to gangrenous affections of the mouth. These conditions require surgical attention.

Treatment.—General treatment of these cases should be corrective by administration of cathartics, regulation of the quantity of water to be taken during each twenty-four hours, administration of diuretics if required; the adoption of suitable dietetic rules by the increase of vegetable food if there be tendency to scurvy, limiting the amount of red meat, and additions to control the carbohydrates. Careful attention should be given to secure nourishment that will be strengthening and at the same time easily assimilated, and effort should be made to overcome directly the condition of acidosis.

The loose teeth, if the possibility of their retention be hopeless, should be removed; those that can be retained should be fastened by retaining appliances, or bridge-work which will attach them to other teeth in the mouth. Malocclusion is invariably present whether the teeth are regular in form and position or not. The occlusal surfaces must for this reason be ground, and the teeth protected by appliances against movement in all directions. The distributions of the stress so that in closure of the jaws it will be divided among a number of teeth instead of being applied to each single one, gives a steadiness that not only relieves the local irritation, and helps constructive cell efforts to restore and enable the tissues immediately surrounding the roots to become tightened and more healthful, but causes at the same time an abatement of nervous symptoms which is quite generally beneficial.

One of the most common causes of failure to respond to treatment in these cases, and at the same time a most active factor in extending

destructive pathological processes, is the fact that extension of the inflammatory condition along the pericementum finally reaches the apical end of the root and attacks the nerve and bloodvessels as they pass through the apical foramen to join the general supply, thus causing strangulation at this point, which leads to devitalization and ultimately through infection to gangrenous conditions of the tooth pulp. On account of the fact that there is frequently no cavity or external imperfection noticeable in the crown of the tooth, this condition may not be properly diagnosticated and the pulp chambers of such teeth then become veritable wells of pus, discharging a more or less continuous supply of infection to continue abscesses and necrotic conditions almost indefinitely. Opening through the tooth crown, cleansing and disinfection of the roots are simple measures to be adopted in treatment, but without this care other treatment is absolutely useless. Necrosis and other pathological results, as evidenced in the oral cavity, or extension of disease to other regions, require treatment appropriate to the pathological state, whatever it may be.

For local application the tincture of iodin, or Talbot's iodoglycerol, may be used with benefit:

Zinc iodide	15 parts
Distilled water	10 "
Iodin	25 "
Glycerin	50 "

Since the first edition of this work was written the excitement occasioned by the theory of the Endameba buccalis as an etiological factor *per se*, and the use of emetin as a positive curative agent has come and gone, leaving behind it a measure of truth and some interesting facts that when properly applied may have therapeutic value. Since the publication in the August, 1914, number of the *Dental Cosmos* of the article by Dr. Allen J. Smith, professor of pathology in the school of medicine of the University of Pennsylvania, and M. T. Barrett, D.D.S., instructor of normal histology in the same institution, relating to the presence of parasitic amebæ in pyorrhea alveolaris and their belief in the use of emetin for its treatment, much has been written by Bass and Johns and other writers, the effect of which, coming as it did from men in high authority, has been almost vicious in its influence upon the methods of treatment of this disease. The theory of the efficacy of emetin is largely based upon the findings of Col. Leonard Rogers, of the Indian Medical Service in Calcutta, who in 1912 demonstrated this to be a useful as well as specific remedy against endameba. In justice to Drs. Smith and Barrett, who have been so widely misquoted, the following extract from a personal letter from Dr. J. Allen Smith to the author, which is quoted from the author's article in Ochsner's *Surgery*, should be considered.

"There are two forms of these parasites which may be found in and about the mouth, viz., *Endameba gingivalis* (Gross in 1849 appears to

have been the first to publish and discover the amebic parasites in the soft material on and about the teeth) and Endameba pyogenes.[1] Apparently either of these two amebæ may be met in pyorrhea pus, but the first is the only one Dr. Barrett and I have found therein. We do not believe that these are alone responsible for pyorrhea suppurations, and do believe pyorrhea may occur without their presence, but we do believe they are present in the great majority of such lesions, which we speak of therefore as amebic pyorrhea. We think their importance comes especially from a symbiosis with the vegetable microörganisms therein found, and we believe we break one link of that symbiotic chain when we use emetin, which is an efficient amebicide, but (so far as known) only a poor bactericide. The chain broken in this wise the suppuration stops. But the same result might be obtained by cleaning out both the amebæ and the bacteria by proper mechanical and antiseptic work, or it might be obtained by efficient bactericides as the exactly suitable vaccine for the individual case. To attack the amebic end of this symbiotic chain by emetin is the easy method, and seems to be providing commonly the most efficient method; but we would be improperly quoted if we were held to regard it as the only method."

The frequent presence of endameba in the discharges from pyorrheal pockets is generally admitted. Their importance as primary etiological factors has, however, been very generally disproved. There seems to be no good objection to the introduction into the pyorrhea pockets, with an ordinary hypodermic syringe properly used, of any of the various preparations of emetin hydrochloride solution in addition to other methods of treatment that have been given. There are, however, many good and sufficient reasons why the general use of the hypodermic administration of half-grain doses of emetin hydrochloride hypodermically each day for three to six days, as recommended by Bass and Johns, should be avoided, except when there is some unusual general indication for such treatment.

Stomatitis Simplex.—A slight more or less transient eruption affecting the buccal mucous membrane. Eruptions of this character are usually coincident with similar affections upon the skin surfaces. These, as is well known, are the outward expressions of digestive disturbances, contagious infections, and specific diseases, and the simplest of all forms of stomatitis, which chiefly affects young infants is also due to gastro-intestinal disarrangement.

Symptoms.—The symptoms are red elevated patches on the mucous membrane of the mouth. They are of bright color, appear suddenly, and usually disappear in the course of a few hours or a few days. Infants so affected usually show other symptoms indicative of disturbed nervous and digestive function, such as unusual flow of saliva, occasional rise of temperature, restlessness, undigested matter, or greenish color of stools, etc.

[1] Verdam and Bryant: L'Écho Méd. du Nord., 1907, xl, 375.

Treatment.—Treatment consists of correction of unhygienic conditions. If the child be bottle-fed, there should be careful sterilization of the bottle, nipple, etc., and readjustment of the formula of its food to conform to the digestive requirements. Plenty of fresh air, cleansing of the digestive tract by administration of castor oil, and high bowel flushing if necessary are also indicated. The mouth should be cleansed with boric or other mildly antiseptic solutions.

Stomatitis Catarrhalis (*Catarrh of the Oral Mucous Membrane*).—**Etiology.**—Stomatitis catarrhalis occurs more commonly in children than adults. Neglected cases of simple stomatitis, direct irritation by heat, liquid or chemical substances, uncleanly conditions of the mouth, chronic disorders of the general system, mouth-breathing, and catarrh of the nasal mucous membrane may predispose or act as direct etiological factors.

Symptoms.—The mucous membrane of the mouth is red and frequently covered with considerable liquid exudate; small vesicular cysts may form from distention of the mucous glands, and sometimes grayish erosions appear.

Treatment.—Treatment requires correction of the general causes by hygienic care, which embraces cleansing of the mouth and body, both externally and internally, and the administration of cathartics, attention to digestive conditions, fresh air, use of mild antiseptic mouth washes. Infants or young children suffering from either simple or catarrhal form of stomatitis should be given careful attention with regard to erupting teeth, and to gums freely lanced, if necessary. Any disadvantageous conditions that may impede the progress of teeth in course of eruption must also be overcome and carious or otherwise diseased teeth properly disinfected and treated.

Aphthous Stomatitis.—Aphthous stomatitis occurs in both children and adults, but more frequently in the former.

Etiology.—It is the result of malhygiene or of gastro-intestinal or other disease. Quite frequently when found in adult cases it is merely an indication of some passing digestive disturbance of temporary nature.

Symptoms.—The little aphthæ or cankers form usually in the folds at the junction of the mucous membrane of gum and lips, or cheeks. Little oval, bright red spots are usually first noticed because of the fact that they are highly sensitive to touch and to sweet and sour substances taken into the mouth. These points of irritation quickly assume a grayish-white appearance, because of the degeneration of epithelium that takes place upon the surfaces. A number of these may occur in the same locality and by confluence become joined into a single large one, but the inflamed outline of the border retains either the original oval form or its shape indicates the joining together of one or more individual oval patches. The lesions are superficial and do not have a tendency to penetrate deeply and to affect the underlying bone structures (Plate VI, Fig. 1).

Treatment.—The local treatment consists of touching the cankers with caustic nitrate of silver or 95 per cent. carbolic acid, followed by alcohol or nitric acid to cauterize the surfaces. Thorough cleansing of the mouth, the use of suitable mouth washes, and, if necessary, correction of the predisposing gastro-intestinal condition.

Bednar's Aphthæ.—These are small ulcers found in the mouths of sucking infants, situated at the lateral portions of the palate and in other places where the surfaces would be likely to be affected by traumatism during the act of sucking, which is their probable cause.

Treatment.—The only remedies suggested in these cases, if the child be bottle-fed, are the administration of nourishment by spoon or with a medicine dropper, and if possible the correction of any irritating habit that may have been acquired, such as thumb sucking or sucking at an empty nipple, as is sometimes allowed.

Ulcerative Stomatitis.—Ulcerative stomatitis is the most difficult of all forms of stomatitis to differentiate from other types of this affection, because the inflamed areas between and around the necks of the teeth affecting the gums and other surfaces of the buccal cavity may be associated with symptoms of many varieties of inflammation of these structures.

Etiology.—It may be the direct result of interstitial gingivitis or may be due to causative factors such as general infection, mineral poisons, disorders of the general system, local irritation, etc., which are usually accompanied by quite similar ulcerative and destructive processes. For clinical purposes it is necessary to make a more or less arbitrary distinction by which we recognize this condition as a disease affecting both children and adults, the former chiefly under conditions of malhygiene, insufficient nourishment, and depletion of the system by long-continued fevers or the effect of the various eruptive diseases common to early life and older persons from general uncleanliness, dissipation, excessive smoking or drinking, and similarly induced factors.

Symptoms.—This form of stomatitis is noted for its grayish-white slough of irregular outline; it usually begins at or close to the gum margins and extends until it includes adjacent tissues. It is distinguished from aphthous ulcers by its irregular outline and the tendency to begin upon the gum rather than the cheek or lip surfaces, and by the fact that it attacks the bone and deeper structures; from pyorrhea alveolaris because instead of clearly defined pockets with pus secretion it spreads out upon the surface and the process is an ulcerative one; from mercurial, syphilitic, and other diseases of the mucous membrane of the mouth by recognition of their special etiological factors. It frequently leads to extensive necrosis of the maxillary bones in children, particularly between the ages of five and twelve years. This is doubtless due to the fact that the jaws are, at this particular time, so filled with developing teeth that the actual bone resistance and blood circulation are reduced, and also because at this period the diseases incident

PLATE VI

FIG. 1

Aphthous Stomatitis

FIG. 2

Gangrenous Stomatitis.

FIG. 3

Noma.

to childhood, both local and general, predispose to affections of this character.

Prognosis.—If the underlying cause has been properly reached, the recovery and improvement should be prompt. When it occurs slowly, one should be on guard against some factor that may have been overlooked.

Treatment.—Clean the teeth, remove the tarter and other irritating substances from between and about their necks. Remove or disinfect diseased roots of teeth, curette sloughing gum margins, and smooth with a bone curette or dental engine bur the roughened borders of the alveolar process. Paint the gum border and entire diseased surfaces with tincture of iodin; correct the etiological factors whatever they may be. (For treatment of necrosis of the jaw resulting from this disease, see Necrosis, page 326.) Direct improvement of dietetic and hygienic conditions. In young children attention should be given to developing unerupted teeth which may become involved and through their devitalization act as complicating factors aiding in continuing infection. Appropriate treatment is demanded in all cases showing enlarged tonsils, adenoid vegetations in the nasopharynx, irregular and contracted dental arches, and deflected nasal septa, all of which are usually associated in anemic, ill-developed children. Nervous and other habits that may be indications of continued irritation in other parts should also receive due attention. In the author's experience adult patients suffering from this affection have usually been those who smoked excessively, particularly cigarettes, who drank liquor freely, or depleted their systems through other habits of dissipation, or who had disease of the kidneys, liver, and other organs, and particularly diseases of the blood, such as acute leukemia and pernicious anemia, of which it is usually one of the earliest symptoms. Local causes in many of his cases were irritations and infection from neglect of brushing the teeth or cleansing the mouth. More often, however, the insertion of bridges between teeth without due care for self-cleansing, and with disregard of occlusal conditions, not only favored the collection of débris under and around them, but in closure of the jaws the unusual stress of malocclusion kept up a chronic irritation and reduced the resistance of the tissues to bacteria. All irritating dental conditions, crowns, bridges, plates, or whatever they may be, should be removed at once. Immediate reform with regard to smoking and other habits must be insisted upon. Urine for twenty-four hours saved and carefully analyzed and its indication followed in treatment. In serious or persistent cases a careful blood examination should be made. By reference to the case described under the heading Leukemic Stomatitis, p. 164, the importance of these examinationns will be better understood.

Gangrenous Stomatitis (Plate VI, Fig. 2), **Cancrum Oris, Noma** (Plate VI, Fig. 3).—Gangrenous stomatitis usually attacks the gums or cheeks, the slough extending until it involves a considerable portion of the face.

Etiology.—This disease is undoubtedly of infectious origin. While attempts have been made to identify a specific germ, the results in this direction have not been such as to warrant general acceptance. The bacillus described by Lingard has been found in a small percentage of cases, but streptococci, staphylococci, leptothrix, and other microorganisms have been identified in these cases so frequently that there seems to be no doubt that the affection is polymicrobic. It frequently follows measles, whooping-cough, scarlet fever, and other infections. In these cases there seems to be some underlying systemic condition which predisposes to gangrene rather than to other manifestations of mouth infection. Although most commonly affecting ill-fed and uncared-for children and those debilitated from disease between the

Fig. 77.—Gangrenous stomatitis. Girl, aged five years. (Courtesy of Dr. R. C. Young.)

ages of two and twelve years, there is no actual age limit. With older persons it is almost invariably an expression of some pathological state of general character, such as pernicious anemia, leukemia, tuberculosis, diabetes. In one of the author's cases of noma affecting a girl nine years old the characteristic spirilla and fusiform bacilli of Vincent's angina were found as illustrated and described in connection with that affection. Weaver and Tunnicliffe have previously called attention to these microörganisms in noma.

Symptoms.—The following descriptions of examples from the author's practice are given as practical illustrations of the symptoms of this disease.

An unmarried man, aged twenty-two years, until recently in robust

health, was referred by his physician, after about two weeks' treatment, suffering from the discharge of a dark fluid on the distal side of the left inferior third molar, a temperature of 104°, not much swelling, practically no pain. A dark-colored spot formed on the buccal surface of the cheek, which quickly extended until it opened through the skin. At no time was there any evidence of pus. The black gangrenous masses formed so rapidly that although cleansed from four to six times a day, the dead tissue could be wiped off with cotton swabs at each attempt. Germicides and other remedies seemed to have no effect whatever. It was useless to attempt to excise the dead tissue, because the gangrenous process began immediately at the border of the incision. Bacterial examination showed staphylococcus infection. Notwithstanding the administration of stimulating remedies and suitable

FIG. 78.—Same child shown in Fig. 77, two and one-half days later. The rapid progress of the gangrene may be noted.

nourishment, the patient died about ten days after treatment was begun, and some two or three weeks after the onset of the first symptoms. Death occurred through extension of the gangrenous process to the lungs, black gangrenous masses being expectorated during the last twenty-four hours.

Another case with symptoms of ulcerative stomatitis which quickly extended until gangrene of the palate was established is described with reference to leukemia (page 164), as that proved to be the underlying cause. Large numbers of children, some of whose cases are described under the heading Necrosis, page 326, did not reach the author until sequestra of the maxillary bones required removal. Most of these gave histories of high temperature and general symptoms which were frequently confused with typhoid and other fevers, wrong

diagnoses being made until finally the condition of oral sepsis was so apparent that it could no longer be overlooked. Quite invariably cases of this type recovered quickly after removal of necrotic tissue, local disinfection, and proper general care (Plate VI, Fig. 2, and Figs. 77 and 78).

Prognosis.—With adults, when leukemia, pernicious anemia, or similar blood disorders are the underlying causes, the prognosis is very grave and a fatal termination is likely to result through inability to overcome the first causes and the lack of resistance thus afforded in combating the toxic effect of the gangrenous processes.

In other cases prognosis is favorable except with regard to cicatricial contraction which sometimes results, and causes more or less serious deformity.

Treatment.—Antiseptic dressings and the excision of gangrenous tissue must be supplemented by measures designed to overcome the underlying cause and to build up the general system.

Antitoxic serum in this, as with other affections of similar character, is deserving of due consideration, even though its therapeutic value in these cases is not fully established.

Parasitic-mycotic Stomatitis or Thrush.—This is an affection which occurs most frequently in nursing children, though occasionally it is seen in adults after or during acute processes or chronic diseases.[1]

Etiology.—It is a parasitic infection due to the thrush fungus, generally termed Oïdium albicans.

Symptoms.—The erosions are white, or creamy white in color, and usually begin upon the tongue or cheek and spread to the tonsils, palate, pharynx, esophagus, or lips. They may resemble flakes of curdled milk or may become brownish from the infiltration of extravasated blood. It is distinguished from other forms of stomatitis by the presence of the fungus and marked dryness of the mouth instead of the reverse condition which usually accompanies stomatitis, especially in infants and children.

Treatment.—The parasite seldom infiltrates the epithelium of healthy individuals. It is therefore rarely seen except among ill-nourished or debilitated children. The first correction of hygienic and constitutional predisposing causes should therefore be by cleansing the alimentary tract with castor oil or small repeated doses of calomel, supplemented by bathing, fresh air, and strict attention to diet. If bottle-fed, as such infants usually are, the formula of the nourishment must be properly adjusted, bottles, nipples, and other accessories thoroughly sterilized, and the mouth swabbed with boric acid or other mildly antiseptic solution.

Foot-and-mouth Disease.—Foot-and-mouth disease is a disease of the lower animals, most common among cattle, but believed to be infectious to man.

[1] Coplin: Manual of Pathology, p. 676.

Etiology.—Brush, after careful study of the review of the literature of the subject, and an exceedingly painstaking investigation among dairymen and in communities supplied by herds having been affected by foot-and-mouth disease, concludes that "there is an aphthous condition of the young in both the bovine and human family which is not contagious, and there is an aphthous condition in both these species that is contagious." Proof of this is presented by reports of cases of children and older persons who were affected by aphthous ulcers and other more general symptoms of foot-and-mouth disease, after drinking milk of cows at the time suffering from the affection, and of dairymaids who contracted herpes on fingers and toes from milking cows having the herpetic eruption of this disease. The disorder is assumed to be due to the pathogenic action of an ultramicroscopic virus.

Pathology.—Pathologically the disease is characterized by inflammation, with considerable thickening of the corium, and vesicles from the Malpighian layer which generally rupture, exfoliate, and cause ulcers.

Symptoms.—There may be many simple erosions without vesicles, or the ulcers may become confluent and spread over considerable areas of the surface of the mouth. In animals there is often fever and a similar eruption upon the feet. Usually the disease in cattle runs its course in about ten days, and with humans in a somewhat shorter period, unless complications arise. Many instances are reported, however, in which calves have dropped dead immediately after sucking an affected mother.

Treatment.—The treatment is to stop the milk by changing to that of healthy animals, or, if uncertain of this, to boil the milk. Give local treatment to relieve pain and other distressing symptoms. Cleanse the intestinal tract and assist general support until the symptoms have run their course.

Pseudomembranous Stomatitis.—Etiology.—This affection is most commonly caused by the Klebs-Loeffler bacillus, and under these conditions is diphtheria of the mouth. It is generally agreed, however, that pseudomembranous inflammation may be induced by certain kinds of irritation without bacteria, and also that it may result from infection by streptococci, staphylococci, and pneumococci as a complication of pneumonia. Other bacilli have sometimes been recognized as exciting causes. Notwithstanding this, however, it is commonly accepted as diphtheritic. Clinically this is much the safer ground to take and regulate treatment accordingly.

Symptoms.—Marked hyperemia is followed by exudate in the submucosa, fluid exudates and leukocytes pass through the surface, and by necrosis form a grayish-yellow, dirty membrane which occasionally is quite dark. Ulcers may form as dead tissue is thrown off. The clearly defined outline indicative of the early stages becomes lost as the destructive process proceeds.

Treatment.—Injections of antitoxin and good general care.

Phlegmonous Stomatitis.—Phlegmonous stomatitis[1] affects the lips more frequently than other portions of the mouth.

Etiology.—Traumatic injuries with intense infection may be causes or it may be secondary to facial erysipelas or other cellular inflammation of the face.

Symptoms.—The lips and cheeks become swollen, with tendency to suppuration and the formation of abscesses which may rupture within the mouth. Hypertrophy of the deeper tissues of the lips sometimes follows a chronic form of this infection, especially of the upper lip in cases of long-standing coryza or eczema.

Treatment.—Remove the cause if possible. Give general treatment if necessary to restore healthful bodily conditions and local treatment by the application of non-irritating, antiseptic, preferably alkaline mouth washes, and upon the skin surfaces lanoline, vaseline, or other suitable salves or dusting powder as may be indicated. In addition to this, the surfaces of the ulcers within the mouth should be thoroughly cleansed with dioxogen.

Tuberculosis.—Etiology.—Tuberculosis of the mouth may occur as a direct result of primary infection of the tissues by the Bacillus tuberculosis, or it may be secondary to tuberculosis of adjacent parts, or be an extension from lupus of the face.

Symptoms.—Primary infection is usually evidenced by nodular masses in the form of papillary elevations with tendency to form tuberculous ulcers which become caseous and infiltrated by tubercles.

Treatment.—See Tuberculosis, p. 103.

Actinomycosis.—Actinomycosis (lumpy jaw) is also a disease common to cattle, horses, swine, sheep, the dog, and other animals, both domestic and wild. It affects the gums, alveolar and other tissues, the mucous membrane surfaces of the mouth, as well as the tongue and the maxillary bones. As these structures are usually jointly involved in this affection, its full consideration is taken up under Infectious Diseases, p. 129.

Leukemic Stomatitis.—Leukemic stomatitis has already been referred to in describing gangrenous stomatitis, because in acute leukemia the gums become inflamed and the formation of ulcers quickly leads to necrosis and hemorrhagic inflammation. The affected tissues present much the same appearance as in other similar conditions. It is one of the symptoms of leukemia, a disease of the hemogenic organs characterized by increase in the number of leukocytes in the circulating blood, and by pathological changes in the bone marrow, spleen, and lymphatic glands.

Detailed consideration of the nature and treatment of leukemia does not properly come within the province of this work, but in the diagnosis of the form of stomatitis, of which it is the underlying cause, its importance is vital. Both the value of a blood count in recognizing

[1] Stengel: A Text-book of Pathology, p. 544.

the affection and the utter hopelessness of attempted cure of the mouth lesions by local treatment are illustrated by the following description of one of the author's cases:

FIG. 79.—Leukemia: Section showing necrosis of mucous membrane of the mouth.

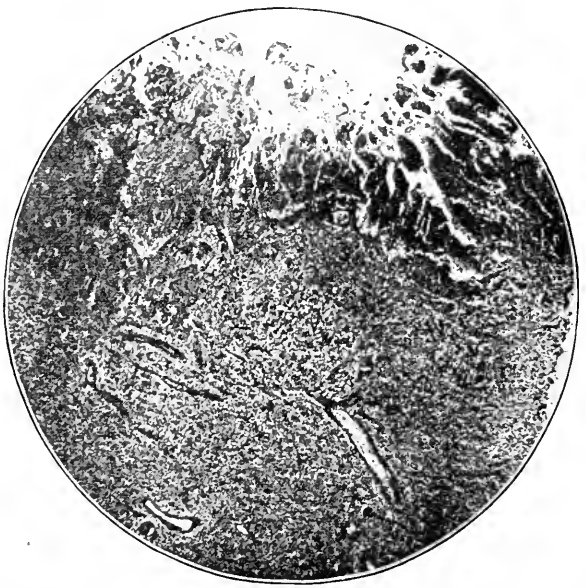


FIG. 80.—Leukemia: Section of the inner wall of the cecum, taken from the same individual as Fig. 79.

A workman, aged fifty-four years, married, of good habits and family history, so far as could be learned, with several healthy appearing

FIG. 81.—Leukemia: Section of the same case as Figs. 79 and 80, cut through the muscular coat of the cecum, showing periarteritis and thrombus.

FIG. 82.—Leukemia: Section of spleen, from same case as Figs. 79 to 86 inclusive.

children, gave a history of some months of ill health, but was until recently able to work.

FIG. 83.—Leukemia: Section of liver, from same case as Figs. 79 to 86 inclusive.

FIG. 84.—Leukemia: Section of kidney, from same case as Figs. 79 to 86 inclusive.

His anemic appearance was marked, but having formerly been of rugged constitution, he was able to get out of bed and go about the

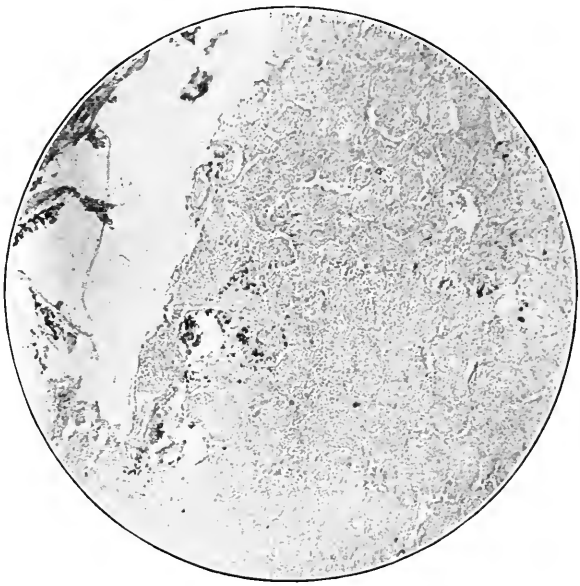


FIG. 85.—Leukemia: Section of lung, from same case as Figs. 79 to 86 inclusive.

FIG. 86.—Leukemia: Section of heart, from same case as Figs. 79 to 86 inclusive.

house without assistance. Examination of his mouth disclosed interstitial gingivitis chiefly on the lingual side of the upper incisors, with gums and buccal mucous membrane in foul condition and tongue heavily coated.

Every effort was made to build up the depleted system. Alcohol baths, beef peptonoids, bone marrow, and other nourishing agents were prescribed, and these supplemented with hypodermic administration of strychnin, normal salt solution per rectum and directly into the tissues, etc.

The last blood count was as follows:

Name.	Normal.	Present condition.
Red corpuscles	5,000,000	1,500,000
Hemoglobin	100 per cent.	30 per cent.
Corpuscle index	1 per cent.	1.3 per cent.
White cells	7000	105,000
Polymorphonuclear neutrophiles	70 per cent.	8 per cent.
Small lymphocytes	8 per cent.	26 per cent.
Large lymphocytes	20 per cent.	60 per cent.
Remnants of leukocytes	25 per cent.	6 per cent.
Megaloblasts	....	1 to each 100 leukocytes
Normoblasts	....	1 to each 100 leukocytes

Bacteriological examination of the lesion showed staphylococcic infections. Temperature ranged from 100° to 102°, with pulse indicative of increasing muscular weakness, both ranging higher toward the last.

Mental faculties were clear until about forty-eight hours before death, which occurred about ten days after the author first saw him.

Operation was attempted for the purpose of removing the necrotic tissue that rapidly increased toward the end. An opening was made through the hard palate into the nares, but the bone was found to be dead in every direction so far as it seemed advisable to remove it. Gangrene of the soft tissue was so rapid that black masses were removed at each dressing several times daily.

The essentially interesting feature of this case is the lesson taught by the blood count, which indicates leukemia, the microscopic sections of the tissues of the mouth at the seat of the oral affection, and others of important visceral organs, each of which shows practically the same areas of inflammation (Figs. 79 to 86 inclusive).

Glanders.—Glanders is another disease of animals communicable to man, which sometimes affects the tissues of the mouth and the pharynx. (For further reference see p. 134.)

Etiology.—Glanders infection is caused by the Bacillus mallei. When involving only the skin and adjacent glands it is called *farcy*. When the mucous membrane is affected, the condition is termed glanders. Usually it is communicated to man from the horse, although it affects a considerable variety of domestic and wild animals. The

bacilli commonly gain entrance through some abraded or wounded surface in the skin or mucous membrane.

Pathology.—It first appears in the form of a small nodule which contains the almost pure leukocytic infiltrate, a few giant cells, and the characteristic bacilli. This increases and produces an ulcer which usually results in a series of ulcers that may or may not become confluent. Extension through the lymphatic system sometimes leads to a chronic condition. In acute cases multiple abscesses throughout the body sometimes cause death from exhaustion and toxemia.

Diagnosis.—Mallein is prepared from the bacilli and used for diagnostic purposes in the same manner as tuberculin for tuberculosis.[1]

Leprosy.—In common with other diseases manifesting themselves upon the skin surfaces, leprosy also affects the mucous membrane of the mouth. (See Leprosy, p. 139.)

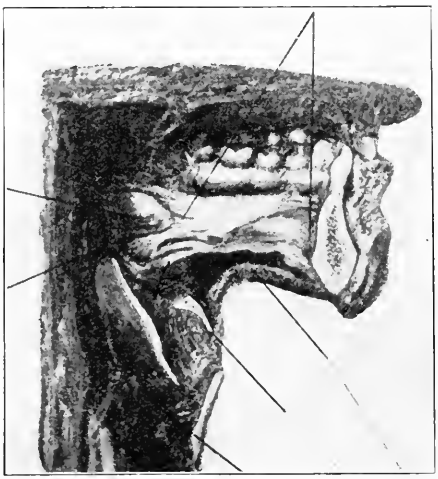


FIG. 87.—Ludwig's angina: Section through jaw, showing the ulcerated condition of the floor of the mouth and other parts as indicated by the lines. (After Thomas.)

Ludwig's Angina or Diffuse Suppuration of the Floor of the Mouth.—Diffuse submaxillary cellulitis, or acute infectious submaxillary angina, is a septic condition affecting the tissues of the floor of the mouth.

Etiology.—Infection usually occurs from ulcers, necrotic conditions of the mucous membrane of the mouth, injuries to the floor of the mouth or extension of disease from the pharynx, lungs, etc. The microorganisms usually found are streptococci, staphylococci, pneumococci, and other pyogenic bacteria.

Symptoms.—Ulcers form under and around the tongue; occasionally there are abscesses. Induration of the tissue sometimes forces the tongue upward and backward until the swelling occupies the entire

[1] Coplin: Manual of Pathology, p. 161.

submaxillary space. It may extend downward into the neck or involve the pharynx, larynx, and tonsils (Fig. 87).

Treatment.—The treatment comprises general disinfection of the mouth, direct treatment of the ulcers and relief of the abscesses if necessary, hot applications to control external swelling if this symptom be present in sufficient degree, thorough cleansing of the alimentary tract with cathartics, and treatment or removal of the primary cause, or of such irritating factors as may exist. In extreme cases tracheotomy is sometimes required to prevent suffocation when the affected parts are so swollen as to interfere with normal respiration. Nourishment per rectum is usually required for the same reason (Fig. 88).

FIG. 88.—Ludwig's angina: Shows characteristic position of head in the effort of respiration. (Case of Dr. R. C. Young.)

Vincent's Angina (*Diphtheroid Angina*).—Vincent's angina is an inflammatory lesion usually appearing in the mouth as an acute stomatitis or pharyngitis, but most frequently as a tonsillitis. A pseudomembrane soon forms which resembles that caused by the diphtheria bacillus. At a later stage ulcers form with well-defined borders not unlike syphilitic ulceration. It most commonly affects children.

Etiology.—It is believed to be caused by a spindle-shaped or fusiform bacillus accompanying which is usually found a spirillum. (See Fig. 89.)

Treatment.—Unless complicated by other conditions, as not infrequently occurs, these ulcers yield readily to mild cleansing antiseptic treatment. It sometimes is associated with diphtheria, and aggravates this affection quite seriously. When it complicates cases of specific fever Osler says it is very fatal. Weaver and Tunnicliffe have found the characteristic spirilla and fusiform bacilli in cases of noma. The author also found fusiform bacilli in a case of noma affecting a young

girl about nine years old, with the typical opening through the cheek. This child died in spite of every effort to overcome the affection, but

FIG. 89.—Vincent's bacillus with accompanying spirochetes.

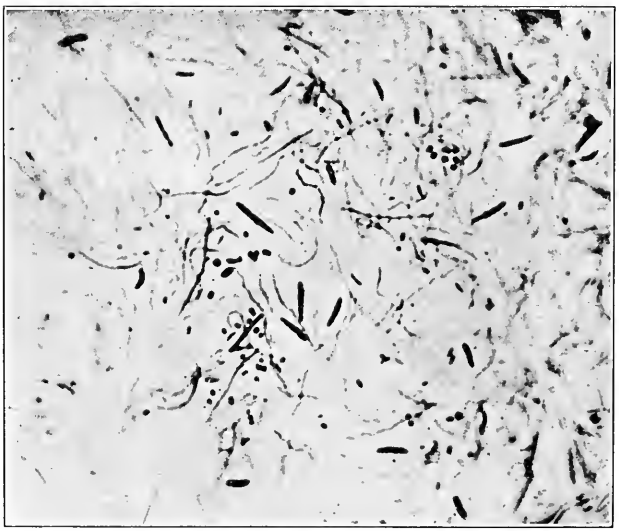


FIG. 90.—Photomicrograph of smear from the cheek of a young girl with noma. Shows the characteristic spirilla and fusiform bacilli of Vincent's angina. (Prepared by Dr. V. A. Latham.)

it was impossible to say whether the fusiform bacilli were the real factors in causation of the disease, or only incidental for streptococci (see Fig. 90) which were also present.

Gonorrheal Ulceromembranous Stomatitis.—Infection by the gonococcus of Neisser occurs in adults, and has also been observed in the newly born and at later periods of infancy.

Etiology.—Menard[1] claims that gonorrheal ulceromembranous stomatitis is always secondary to profound systematic infection, but this is opposed by many authorities and much clinical evidence, which leads to recognition of direct local infection by gonococci as the cause.

Symptoms.—The symptoms are catarrhal or mucopurulent inflammation, particularly involving the mucosa of the gums and cheek. Sometimes a dirty gray coating, resembling a pseudomembrane, is formed.

S. M. Hyman[2] reports the following case of a girl, aged eighteen years: "She first complained of terrible pain and burning in the cheeks and mouth. Intense pain caused by swallowing either liquid or solid food. The mouth felt parched; there was foul-smelling expectoration which contained traces of blood. Constant nausea was felt. Uvula, soft palate, and cheeks were covered with a milky white membrane with occasional bleeding spots. The membrane was non-adherent, and on removal showed a red inflamed surface resembling the scarlatinal blush. The tongue was red, swollen, and painful, the patient being unable to protrude it completely. The gums were spongy, markedly retracted from the teeth, and bled freely on handling. The buccal temperature was 99.7° F. The pulse and respiration were normal. The pseudomembrane consisted of mucous epithelial and pus cells, within and around which were groups of staphylococci and diplococci, the latter having all the characteristics of the gonococcus of Neisser."

Treatment.—The treatment described by Hyman in the above case is a good example of what the treatment of such cases should be. Calomel in 10-grain doses at bedtime, daily applications of silver nitrate solution, 1 to 250, in the beginning, gradually increasing to 1 to 50 as the symptoms disappeared (about the sixth day), gargles of saturated solution of boric acid and alum, 1 to 1000, were used until the cure was complete.

Pemphigus.—Pemphigus is an acute or chronic inflammatory disease of the skin, characterized by recurring eruptions of variously sized blebs, accompanied by systemic disturbance, and often ending fatally. The mouth and other mucous membranes may become involved. In the variety known as pemphigus vegetans, the mouth, vagina, or other mucous membranes are usually first affected.

Etiology.—Pemphigus is a rare disease and its etiology is obscure. Toxins derived from various sources and acting on the nervous system offer the best explanation of its phenomena.

Symptoms.—It may be confined to mucous membrane surfaces, or the skin may also be affected. Vesicles form upon the mucous membrane of the lips, cheeks, tongue, and palate. Bullæ may also form

[1] Practical Medicine Series, 1904, x.
[2] New York Med. Jour., January 25, 1907.

in the nasopharynx, esophagus, conjunctivæ, vagina, stomach, and throughout the intestinal tract. Chills, fevers, and other indications of toxic disturbances are evidenced under these conditions. Swelling of the tongue and painful difficulty in taking nourishment cause emaciation.

Prognosis.—The prognosis in cases of this character is grave, because of the serious nature of the primary causes and rapid loss of bodily resistance occasioned by difficulty in taking food.

PIGMENTATION.

Etiology.—Stengel[1] divides pigmentation into four groups, according to region and variety: (1) Those in which the pigments are derived from external sources; (2) those derived from the hemoglobin; (3) those derived from the bile; (4) those derived from the cellular activity within the organisms.

Symptoms.—The manifestations may be local or general. Among the former are the pigmentations of nevi and moles, of pregnancy, and of the corpus luteum, freckles, some scars, and certain skin diseases, as chloasma and xanthelasma, of the lesions secondary to the more cutaneous parasites, etc. The special local type is that seen in tumors, notably in melanosarcomata. Lipomata and sarcomata (chloromata) may be analogously affected. Among general pigmentations are those of Addison's disease, certain severe anemias and cachexias, tuberculosis of the peritoneum, intestines, and retroperitoneal glands, and those of abdominal neoplasms and senility. The cases associated with abdominal lesions are held to be connected with disturbances of the adrenal bodies or of the splanchnic sympathetic system, which has been considered to have control of pigment formation.[2]

The mucous membrane of the mouth may be affected in the following conditions:

Pneumonokoniosis.—This is the result of inhalation of dust, from coal, iron, stone, and vegetable products. The fine particles are deposited along the bronchial walls, and carried by the phagocytic cells into the submucosa or by the lymphatic circulation into the peribronchial, the mediastinal glands, and deeper tissues of the lungs and in rare instances to other regions of the body. In some cases the mucous membrane of the lips and mouth becomes pigmented.

Argyria.—The skin and the mucous membrane of the mouth, gastric and intestinal walls sometimes become pigmented as a result of excessive ingestion of soluble salts of silver.

Hematogenous Pigmentation.—This form is due to the deposition of pigments derived from the hemoglobin. In pernicious anemia, leukemia, malaria, severe cachexias, in occasional infectious and septic processes, and in various kinds of poisonings, hemoglobin is set free

[1] Text-book of Pathology, p. 90.
[2] Ibid., pp. 95 and 96.

in the circulation and results in pigmentation. In diabetes and cirrhosis of the liver and pancreas, a variety of hematogenous pigmentations occur. They vary in color from a rusty red to a dark black. Local pigmentations occur from thrombosis, interstitial gingivitis, and coagulation.

Hepatogenous Pigmentation.—In jaundice the bilirubin and its exudation product, biliverdin, are deposited as pigments, either in solution of granular precipitations, or crystals in the liver, skin, mucous membrane and other tissues. The color, at first yellow, gradually deepens to a deep olive, or may become brown or greenish.

Metabolic Pigmentation.—Pigmentation derived from cellular activity.

Treatment.—Upon skin surfaces, local pigmentation, such as nevi, moles, etc., require local treatment for their removal; but upon mucous membrane surfaces the treatment of all forms of pigmentation relates directly to efforts to overcome the primary cause or general condition. Locally considered, the symptoms are chiefly of diagnostic value as evidence of the progress of or recovery from general diseases.

TRAUMA.

Traumatic injuries to the surfaces of the mucous membrane of the lips, cheek, and tongue are of much more frequent occurrence than is generally recognized, and are often of very great pathological importance. Nervous habits, favored by loss of teeth, improper interproximate spaces leading to the lodgment of particles of food between teeth, sharp borders of exposed surfaces of carious teeth or roots, malocclusion of teeth, malformed, ill-fitting, imperfectly constructed tooth crowns, bridges, plates, and other dental work in the course of time are apt to cause habits of biting the cheek or lips or rubbing the tip or sides of the tongue against these roughened surfaces. The habit once acquired, such action is performed subconsciously, therefore the patient is conscious only of the fact that occasionally there are irritated or abraded surfaces upon the mucous membrane in these situations. Such chronic irritation occasionally leads to quite severe symptoms through infection and other contributing factors. More often, however, the danger lies in chronic thickening of the mucous membrane surfaces, which make itself apparent in the form of ulcers, or the mucous membrane in that region may take on the appearance of leukoplakia; and under such conditions there is always likelihood of the occurrence of cancer in these situations. Nervous habits of the lips, jaws, and tongue are by far too little appreciated in their pathological importance. In the author's practice a number of cases of recurrent swelling of the cheek, some of them with histories extending over a period of several years, for which there appeared to be no known cause and which gave grave disturbance, were finally found to be the result of infections due to irritation induced by cheek biting. In another case the opportunity

for infection by the tetanus bacillus was brought about in the same manner. Quite frequently benign ulcers, diagnosticated as cancer, have been cured by removal of irritating tooth surfaces; on the other hand, many cases of cancer which have passed beyond surgical control before being properly diagnosticated, appeared to owe their first existence to chronic irritation of this character.

Treatment.—Smooth rough tooth surfaces in the vicinity of the irritation, round sharp tooth borders, treat carious teeth, and correct such imperfect interproximate spaces or other dental imperfections as may be necessary to relieve the trouble; instruct the patient to endeavor to overcome the habit, apply tincture of iodin to the irritated surfaces until acute inflammatory symptoms have subsided, and then give repeated coating with glycerole of tannin to toughen and give temporary resistance to the exposed surfaces.

BURNS AND SCALDS.

Etiology and Symptoms.—Burns and scalds of the lips and mouth may occur from direct application of heat or flame, from solutions or drugs, the sun's rays, electricity, *x*-rays, etc. They are classified as follows: First degree, erythema or congestion of skin surfaces; second degree, vesication; third degree, destruction of skin and deeper tissues.

Burns of the mucous membrane of the mouth are most commonly due to liquids that are too hot, or drugs in sufficient strength to cauterize and destroy the tissues with which they come in contact. They may also be caused by the inhalation of flame or hot steam or fumes from burning chemicals. In these cases there is usually injury to the lungs and bronchi also. Quite frequently little or no painful sensation is experienced immediately following the inhalation of steam, and yet death follows soon thereafter as a result of pulmonary edema. A large number of the twenty-one persons injured in the accident to the Twentieth Century Limited train some years ago, who inhaled live steam from the burst pipes, were able to talk and give their places of residence shortly afterward, their only complaint being a tickling sensation in the lungs and bronchi. Yet one by one they dropped dead in the course of a few minutes. The fumes of sulphuric and nitric acid in a fire at Milwaukee brought death within a very short period to a number of firemen who inhaled them.

Treatment.—When lungs and bronchi are involved, little can be done, and this only by way of vapor and nebulized oil containing soothing alkaline properties. If the tissues of the mouth alone are involved, normal salt solution may be freely used. Carron oil, and paste of bicarbonate of soda and oil may be applied to the surfaces. Pain can to some extent be relieved by the use of a 2 per cent. solution of cocain and normal salt. If the burn has occurred from carbolic acid in attempted suicide or accidental injury, the immediate use of alcohol to neutralize and stop the further destructive action of the acid is

demanded. Milk, lime-water, and bicarbonate of soda are also useful in emergency. Saturated solution of carbonate of soda in oil, held in the mouth is a valuable agent. Upon the skin surfaces of the lips slight burns may be coated with collodion, or dressed with saturated solutions of sodium carbonate or carron oil solution. Picric acid on dressing for five or six days, followed by vaseline and lint and later by a soothing ointment, gives good results in ordinary cases. Vesicles as they form must be opened, shreds of tissue removed, and sloughing surfaces relieved by touching with swabs dipped in dioxogen followed by any non-irritating antiseptics, such as 2.5 per cent. solutions of carbolic acid, which is especially good for this purpose. With extensive burns of other portions of the body, the shock is usually profound. When

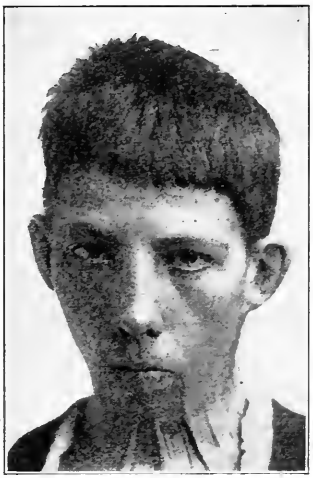


FIG. 91.—Boy, aged fourteen years, burned in the neck at the age of three years. Scar tissue has completely arrested growth in the mental region of his lower jaw.

FIG. 92.—Same boy shown in Fig. 91 after operation. Removal of scar tissue, skin grafting, and the formation of a chin from soft tissue has effected the change.

they involve one-fourth or more of the cutaneous surface, death usually occurs. The extensive suppuration which sometimes follows brings about extreme exhaustion and disease of the kidney, with quite frequent fatal result. In such cases the best treatment, by all means, is immersion of the body in a normal saline solution bath. Hypodermic injections of morphin are necessary to relieve the extreme pain. Stimulants and the application of heat to body surface, wet packs of normal salt or bicarbonate of soda solution are also useful. Successes claimed for "ambrine" in the treatment for burns has led to the very general adoption of various paraffin mixtures in the treatment of wounds and burns. With this protecting agent anesthetic and antiseptic agents are sometimes used. The surface is dried with cotton pledgets dipped in ether; a coat of liquid petrolatum applied, and over this the

FIG. 93.—Man, aged twenty-one years, who was burned in the neck when three years old. Scar tissue caused unusual length and thickness of lower jaw.

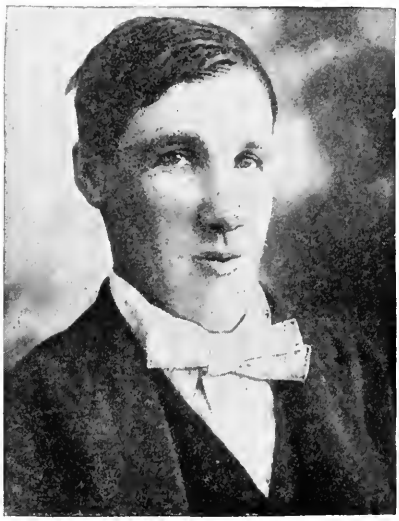


FIG. 94.—Same man shown in Fig. 93 after operation. The lower jaw was excised from the bicuspid tooth forward and a mental process fashioned out of the thick jaw-bone that remained.

warm paraffin. The effect is soothing and the repair of the wounds facilitated because the paraffin film does not adhere to the injured area and the granulations cannot penetrate as they do in the meshes of the dressing when gauze is applied directly. It is claimed that the resulting scar is less than by other methods.

Effect of Burns.—When contraction of scar tissue following extensive burns results in the destruction of the usefulness of the soft palate, a plastic operation, usually staphylorrhaphy, is necessary to restore speech function. The effect of burns in young children, involving the lower portion of the neck and face, may, by contraction of scar tissue, interfere with the growth of the jaw, mouth, and bones of the face, and cause marked deformity. In these cases much may be accomplished by surgical correction, and the possibilities for usefulness as well as the appearance of such individuals may be greatly improved by the restoration of the bony structures, at least approximately to normal form, and by plastic operations upon the soft tissues, supplemented by skin grafting. Two typical examples of this are shown in Figs. 91 to 94, cases in the author's practice, which illustrate the effect of burns in early life, resulting in deformity, and the benefit of operation.

ERYTHEMA.

Erythema is a hyperemic skin disorder, characterized by redness in diffused or circumscribed non-elevated patches.

In common with other skin eruptions its several forms give more or less manifestation upon the surfaces of the mucous membrane of the mouth, and the following types deserve special mention in this regard.

Symptomatic Erythema.—Symptomatic erythema is a rash quite commonly affecting the mucous membrane as well as skin surfaces.

Etiology.—It is caused by disturbances of the general system leading to morbid states. Drugs and certain foods thus affect individual cases. It may precede or be associated with variola, diphtheria, cholera, meningitis, vaccinia, etc. The chief importance of all these classes of erythemata lies in their resemblance to exanthematous fevers.

Treatment.—Treatment is chiefly directed to correction of the underlying general cause, local use of soothing washes, and general oral cleanliness.

Erythema Multiforme.—Erythema multiforme is an acute disease characterized by purplish-red macules, papules, and tubercles becoming vesicular or bullous. These usually affect the backs of the hands and feet, although they appear also upon the other portions of the body and the mucous membrane.

Etiology.—Systematic disarrangement leading to digestive disturbances and the absorption of toxic elements of the general system are the chief etiological factors. *Erythema iris* and *erythema nodosum*,

as well as other forms in which the eruption is somewhat similar, it is generally agreed should properly be grouped together in this class.

Symptoms.—In many cases the disease is preceded or accompanied by rheumatoid pains, malaise, sore throat, and fever. The eruption develops rapidly, and may consist of macules, papules, tubercles, vesicles, blebs, or hemorrhagic lesions, with one or other type of lesion predominating. Although usually most pronounced on the extensive surfaces of the extremities, any part of the body may be involved, and at times the mucous surfaces of the mouth, eyelids, nose, and throat are affected. The lesions are of characteristic bluish-red color.

Treatment.—General treatment in all such affections includes free administration of cathartics, stimulation of diuresis if necessary, and the administration of suitable tonics. Locally, soothing washes and lotions should be applied, and when nodules exist, especially lead lotions.

Erythema Endemicum, Erythema Pellagrosum, or Pellagra.—Pellagra is an endemic trophoneurotic disease of toxic origin affecting the nervous and digestive systems and producing characteristic changes of this kind.

Etiology.—The disease is supposed to be due to the eating of diseased maize.

It is chiefly found in the countries of southern Europe, but within recent years has been very frequent in the United States, especially in the South.

Symptoms.—Diarrhea, dementia, and dermatitis are the cardina-symptoms. Recurrent attacks of gastro-intestinal disturbance, accoml panied generally by various nervous symptoms, result in progressive physical and mental debility. The cutaneous symptoms may be a marked feature of the disease, and consist of erythematous eruption on the backs of the hands and fingers, forearms, face, neck, upper chest, and dorsum of the feet, resembling "sunburn." This is succeeded by a stage of thickening and pigmentation, and still later atrophy of the skin occurs. In most cases some degree of stomatitis is found which may be sufficiently intense to resemble an advanced stage of mercurial stomatitis. The entire buccal mucosa is then bright red and denuded of epithelium, the gums are swollen and show aphthous ulcers, while the tongue is brightened with enlarged papillæ.

Pellagra pursues a variable course and may recur annually for several years. Its mortality is high, the final stage being one of marasmus.

Treatment.—Good hygiene and nutritious food are important. Lombroso recommends arsenic internally. Salvarsan has been tried without success. Transfusion has recently given some favorable results.

URTICARIA.

Urticaria is an affection characterized by the development of wheals which are accompanied by burning and itching sensations.

Etiology.—The general causes are gastro-intestinal derangements, quite frequently due to a great variety of foods or idiosyncrasy with regard to special food, drugs, intestinal worms, malaria, affections of of the generative organs, chronic disorders of the stomach, bowels, and kidneys, or of the brain and spinal cord.

Local irritations, such as insect bites, coarse underwear, etc., may be exciting factors.

Symptoms.—There may be only a few, or large numbers of wheals may appear suddenly and remain for a few minutes or several hours, then disappear in the same abrupt manner. The skin is usually affected, but mucous membrane surfaces, the mouth, pharynx, respiratory tract, and stomach may also be implicated. In acute cases there are only one or two outbreaks; in the chronic form successive attacks may occur during an indefinite period.

Treatment.—Treatment should be directed to elimination of disturbing food, correction of stomach or other disorders, general cleansing of intestinal tract.[1] Ice held in the mouth and soothing washes are beneficial.

HERPES SIMPLEX.

Herpes facialis is commonly called *fever blisters.*

Etiology.—It is associated with febrile disorders, though it may result from gastro-intestinal disturbance or local irritation.

Recurring forms are frequently seen in syphilitic patients, and may be confounded with relapsing mucous patches.

Symptoms.—This form of the affection usually appears upon the lips, angle of the mouth, and lower part of the face. It also quite commonly affects the mucous membrane of the mouth.

Treatment.—Flexible collodion or other non-irritating coating to protect from irritation and rupture is useful. Attention should be paid to the underlying general condition.

LICHEN PLANUS.

A disease of the skin characterized by red or bluish-red, angular, flat, shining umbilicated papules, usually affecting the anterior surfaces of the forearm, and on subsidence leaving pigmentation.

This eruption develops gradually, the lesions tend to group, and large areas of skin may be affected. It is not unusual to find the disease upon the mucous membrane. In these cases it occurs most often in the mouth, the frequency of affection of the anus, urethra, and larynx decreasing in the order given.

Etiology.—Lichen planus is nearly always of neurotic origin, although digestive disturbances seem causative in some cases.

Symptoms.—Lieberthal gives the following description of lichen planus as it appears in the oral cavity:

[1] Hare: System of Practical Therapeutics, pp. 56 and 57.

"On the cheeks, lichen planus, as a rule, affects that part which is just opposite the interdental space and presents papules, oval or circular plaques, and most frequently streaks or linear projections with intervening furrows. These projections are arranged in different ways, parallel to each other, convergent or divergent, passing each other in different directions and forming networks or stellar or brush-like formations. They all show the character of the elementary papules, are opaline, sharply defined, and painless.

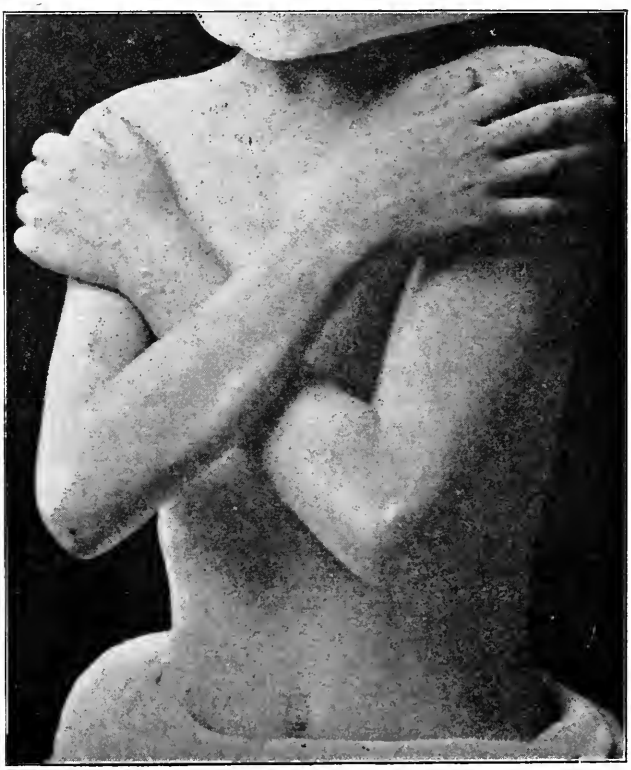


FIG. 95.—Lichen planus. (After Schamberg.)

"The lesions of the tongue differ somewhat. On the back they present irregular, oval, or circular plaques, while on the upper and lower surfaces of the margins solitary papules are found, or, more frequently, irregular or band- and stripe-like plaques. All these differ from the lesions of the cheeks. They are, as a rule, not sharply defined, are smooth, less hard, not raised above the level of the normal surface, not glossy, but dull and grayish white. On the mucous membrane of the lips, the papules form irregular plaques, and on the vermilion border groups of irregular plaques.

PLATE VII

FIG. 1

Lichen Planus.

FIG. 2

Leukoplakia.

PLATE VIII

FIG. 1

Leukoplakia.

FIG. 2

Mucous Patch.

"On the soft and hard palates, and on the gums, solitary and aggregated papules are more frequent than plaques or networks. On the tonsils the more solitary lesion prevails. As mentioned, the older the process upon the mucous membranes, the more do the papules coalesce and lose their distinct outlines, until the elementary lesions cannot be recognized as such. The plaques and streaks lose to a great extent their roughness and hardness, and at last they become so flat that there is no elevation present, but only the shiny white discoloration resembling mucosa touched with silver nitrate. These lesions show no tendency to degenerative changes; no erosion or ulceration occurs. The anatomy is similar to that of the lesions of the skin" (Fig. 95). (Plate VII, Fig. 1.)

The mucous membrane lesions of lichen planus are often only with difficulty distinguished from those of syphilis, and inasmuch as lichen planus is also favorably influenced by mercury the therapeutic test is of no value.

Treatment.—Arsenous acid in steadily increasing doses and regulation of diet are suggested. Local applications are not required. Salicylate of soda is sometimes efficient in cases where arsenic does not give favorable results. Protiodide of mercury is of distinct value in many cases.

LEUKOPLAKIA.

Leukoplakia Buccalis, Leukokeratosis Buccalis, Leukoma, Leukoplasis.—This is a disease of the mucous membrane of the mouth. It may appear upon the surface of the palate, gums, cheeks, but occurs most frequently upon the lips and tongue, and is characterized by white or bluish-white plaques or patches (Plate VII, Fig. 2, and Plate VIII, Fig. 1).

Etiology and Pathology.—Syphilis has been held to be a frequent etiological factor, and of this form the plaques, opaline or milky-white patches, have been held to be pathognomonic (Plate VIII, Fig. 2). Recent writers, however, incline to the belief that syphilis is not frequently a direct cause. Since it affects males almost exclusively and after the age of thirty, and because excessive use of tobacco has been found to be an almost constantly associated condition in such cases, this and local irritation, coincident with the use of strong spirituous liquors, hot fluids, and hot or highly spiced foods, together with digestive disturbances and conditions of the gastro-intestinal tract, due to faulty metabolism and the effect of hypo- or hyperacid conditions of the body, are the chief causes. Local irritation from abrasion by rough, carious, or otherwise improperly cared for teeth; ill-fitting crowns, plates, or dental bridge-work, have also been recognized as of etiological importance. But in the opinion of the author, by far the most important factor may be included under the general description "nervous mouth habits." (See page 173.) All of the factors enumerated would predispose to nervous conditions of the jaw. Constant

pressure or rubbing of the tongue upon roughened or uneven surfaces in the mouth, the biting of the cheeks or lips, and various other habits of like character are subconsciously indulged in, in one form or another, by large numbers of people and undoubtedly account for irritation by roughened surfaces in this affection, even as they do for other local manifestations of disease. The marked tendency to carcinoma, which has been so frequently noted in such cases, has led to the association of leukoplaques with true leukoma which is distinctly carcinomatous in character.

Symptoms.—Usually the affection is not recognized until the white appearance is more or less fully developed, although in its initial stage the patches are slightly red. The circumscribed areas later become white or bluish white, radiating or oval, and by coalescence tend to become large. At this stage the surface is glistening and raised above the surrounding membrane, and though large surfaces may be covered, they quite frequently pass unnoticed, on account of the fact that they are not sensitive at this stage. With progress of the disease the surfaces become hardened, discolored, dry, rough, and by thickening of the epithelial covering more or less raised. This roughened or cornified layer, as the thickening progresses, becomes loosened at the edge. Upon accidental or other removal of this thickened epithelium, the under or interlying surface is exposed and found to be smooth, red, and highly sensitive. Occasionally there is tendency to bleed. At this time there may be acute sensitiveness to irritation, with a burning, dry sensation. Marked fissures and furrows may develop upon the tongue.

Hypertrophy of the papillæ sometimes gives a warty appearance, ulcers ultimately form, and from this usually cancer of the tongue originates.

Prognosis.—The prognosis is serious only insofar as there is danger of carcinoma developing, as it so frequently does on leukoplakic surfaces.

Treatment.—The treatment consists in removal of local causes of irritation, including, if possible, correction of nervous habits by which such irritation is provoked. Attention should be paid to improvement of both local and general hygienic conditions. Abstinence from or at least marked limitation in the indulgence in alcohol, tobacco, or other forms of dissipation are recommended.

Cauterization and the use of escharotic drugs by direct application should be avoided on the ground that they tend to increase rather than diminish the trouble.

Surgical removal of the mucous membrane over the affected area is sometimes required.

ECZEMA.

Eczema is an inflammatory disease of the skin, with diffuse redness and exudation, or with papules, vesicles, or pustules, followed by weeping or scaling, and usually accompanied by much itching.[1]

[1] National Medical Dictionary, p. 49.

PLATE IX

FIG. 1

FIG. 2

Seborrheic Eczema.

FIG. 3

Herpes Labialis.

This affection according to Schamberg,[1] constitutes about 30 per cent. of all of the skin diseases, and is met with at all ages and conditions of life. One of its many forms, eczema labialis, touches the field of our present consideration.

Eczema Labialis.—Eczema labialis is a small pustular form of eczema which affects the lips (Plate IX, Fig. 2).

Etiology.—Its causes are local irritations, and constitutional influences due to alimentary disorders, auto-intoxication, gouty and rheumatic diathesis, functional disorders, and affections of the nervous system.

Treatment.—Schamberg states that eczema of the vermilion border of the lips often runs an obstinate course, and advises the use of lotions of resorcin, boric acid, or ointment of salicylic and boric acids in cold cream. In chronic cases, weak solutions of nitrate of silver and caustic potash. General treatment and hygienic measures should be adopted for correction of the constitutional causes. The following formula is recommended:

℞—Resorcini,
Acidi borici . . . . . āā ℥j
Olein amygdal. dulcis . . . . . f℥ij
Aquæ calcis . . . . . f℥iv
Pulv. zinci oxidi . . . . . ʃ℥iv—M.

PURPURA.

Purpura is manifested by red or purple hemorrhagic patches upon the skin which do not disappear upon pressure. These are usually symptoms of an infectious eruptive disease, such as smallpox, scarlet fever, measles, cerebrospinal meningitis, malaria, diphtheria, and similar affections. Under such conditions there is usually a more or less characteristic and somewhat similar affection of the mucous membrane of the mouth. It may also appear without the association of infectious diseases. Of its several forms, purpura hemorrhagica is of special importance to our subject.

Purpura Hemorrhagica.—Etiology.—It is caused by many different kinds of toxic influences acting through the circulation or upon the vessel walls. These are not alone those incident to infectious diseases, but the poisons of many different kinds of drugs, either by reason of individual susceptibility or otherwise, may also produce similar eruptions, as do also the autotoxins and imperfect metabolism. It is sometimes an evidence of organic disease.

Symptoms.—There is usually languor, headache, and fever. Hemormagic spots of varying size appear upon the skin, and petechiæ on rhucous membrane surfaces with tendency to hemorrhage of the mouth, nose, and other parts covered by mucous membrane. The period of its duration is uncertain, but in the fulminating form, when due to intense septic or toxic influence, rapid death results.

[1] Diseases of the Skin and Eruptive Fevers.

Prognosis.—In purpura hemorrhagica the prognosis is more uncertain than in other forms, because of the possibility of its being an indication of some grave underlying disease and the likelihood of fatality resulting through internal hemorrhage.

Treatment.—Support and stimulate the patient to assist natural resistance. Give easily digested, highly nourishing diet, good hygienic care, alcohol baths. Keep patient in bed. Give rest and quiet. Use astringent mouth washes. Coat the gums and other affected surfaces of the mucous membrane of the mouth with tincture of iodin. When hemorrhage of internal parts is so persistent as to become a menace and refuses to yield to administration of ergot and remedies of similar character, it is the belief of the author that the transfusion of blood from a normal individual is the most efficient way to prevent fatal termination (see p. 41).

Scorbutus, Scurvy, Sometimes Called Purpura Nautica.—Scorbutus is a disease affecting the blood and general system, and is due to the absence of certain articles of diet. It has been recognized from the very earliest ages by frequent historical reference. Modern methods have made possible the preservation of vegetable foods, and for this reason it is now rarely met with.

Symptoms.—Mental depression, marked and progressive emaciation, hemorrhagic spots on the skin, and tendency to hemorrhage of the nasal, buccal, and pharyngeal mucous membrane surfaces, with spongy and bleeding gums, indicative of interstitial gingivitis, are among the symptoms. There is usually chronic diarrhea with pain in the joints and also neuralgic affections.

Diagnosis.—On account of the similarity of symptoms it is sometimes necessary to make careful differential diagnosis between purpura hemorrhagica and scorbutus. This has been summed up by Schamberg in the following form:

SCORBUTUS.	PURPURA HEMORRHAGICA.
1. Occurs in those subject to lack of vegetable food and to bad hygiene.	1. No such etiological relationship.
2. Definite antecedent symptoms: weakness, impaired circulation, etc.	2. Antecedent signs slight or absent.
3. Onset slow.	3. Onset sudden.
4. Gums spongy, swollen, and bleeding; teeth loose.	4. Gums often bleeding, but not swollen.
5. Severe muscular pain.	5. Less marked.
6. Brawny infiltration of lower extremities.	6. Not present.
7. Hemorrhages from mucous membranes, not, as a rule, profuse.	7. Hemorrhages from mucous membrane may be so severe as to prove fatal.

Treatment.—Its treatment should be preventive, by proper regulation of the diet whenever conditions are such as to favor its occurrence. Cure may be effected by dietetic correction, through the addition to the dietary of potatoes, pickles, lime juice, vinegar, citric acid, etc. Rubbing the body and particularly stiffened joints with olive oil is also beneficial. Local treatment consists of thorough cleansing of the

teeth, particularly their necks and exposed root surfaces and the application of tincture of iodin.

Infantile Scorbutus.—This disease is sometimes also called *Barlow's disease*, and some writers, notably Schubert,[1] make an effort to distinguish between the two diseases. It is a form of scurvy affecting infants. Because of its resemblance to other infantile affections it has only been generally recognized during comparatively recent years.

Morse[2] states that when of mild form it is overlooked and mistaken for difficult dentition. Among the thirty infants he examined the trouble had been diagnosticated as rickets, Pott's disease, hip disease, periostitis, gout, syphilis of the cord, acute nephritis, uric acid diathesis, and arsenic poison.

N. Jacobson[3] believes infantile scurvy to be more frequently overlooked than any other pathological condition of childhood. Cases have been reported in which this affection has been mistaken for periostitis, osteomyelitis, and osteosarcoma, and because of erroneous diagnosis operations have been undertaken for the removal of conditions which did not exist.

Among the early valuable contributions to this subject we find an article "Two Cases of Infantile Scorbutus," by Dr. Edward C. Kirk, of Philadelphia, published in the *Dental Cosmos* of June, 1895. Kirk recognized the true cause of this affection through his study of faulty metabolism, and his interest was excited by a case of Dr. J. W. White's that came under his observation, which he reports in connection with one of his own patients. Both these cases and others presented by more recent writers are described in detail below to give a proper basis for comparison of symptoms.

Etiology.—The disease is generally recognized as a form of malnutrition due to either excess or insufficiency of certain food elements, producing changes in the blood in infants similar to those long recognized as indications of scurvy in adults. Authors, however, differ as to the exact nature of the exciting causes.

Stoles[4] attributes it "to the distribution of the ferments in the milk," and Cohns to disturbance in absorption of calcium. Certain authors see no connection between the disease and sterility of the food, but regard it as a manifestation of auto-intoxication in chronic dyspepsia. It is generally agreed that an important factor is the use of proprietary foods in feeding infants.

Kirk says: "There is, however, an important side to this matter of infant nutrition, not by any means so clearly manifest, but which careful investigation will, I think, prove to be a definite outgrowth of the pernicious custom of depending altogether upon proprietary and chemical laboratory food products for the nourishment of infants. I

[1] Deutsch. Arch. f. klin. Med., December 13, 1905.
[2] Med. Rec., October 19, 1907.
[3] New York Med. Jour., December 11, 1909.
[4] Practical Medicine Series, Pediatrics, 1908, vii.

refer to the systemic nutritional disorders so often produced by this custom. Disorders of the digestive tract, with their sequelæ, are sufficiently familiar; they do not only give rise to a number of acute and chronic pathological conditions, but indirectly bring about impairment of nutrition through the inability to properly prepare and assimilate food. This train of evils can be shown to be more closely connected with the indiscriminate use of artificially prepared foods in many instances than the properties of the preparations would be willing to admit. But a special feature which constitutes an important objection to the habitual use of these preparations is one which directly affects the nutritional process, viz., their inadequacy to supply all the elements necessary for the normal nutrition of the individual. Two closely allied conditions directly due to imperfect nutrition, from lack of essential food elements, are rickets and scorbutus."

Schubert states, "the latter (Barlow's disease) affecting infants, has been attributed to the use of sterilized cows' milk." Griffith has seen cases which occurred in infants nursed by their mothers, and which recovered by the use of sterilized cows' milk.

The author has known infants to die of inanition who nursed the breasts of mothers with an abundance of milk which evidently did not contain all of the necessary food elements in proper distribution.

This seems to be the essential point. While artificial foods and even modified milk products are, as a matter of necessity, less perfect, and bottle infants therefore more prone to all forms of digestive nutritional affections, the disease may, nevertheless, occur in individual cases when the mother's milk is insufficient.

Symptoms.—The onset of scurvy is slow. There is a general appearance of malnutrition, such as anemic emaciated appearance, with restlessness and evidence of irritability. The gums over unerupted teeth and around those that are already erupted become spongy, swollen, dark in color, with marked tendency to bleed. Teeth become loosened and are sometimes lost. As the disease progresses the maxillary bones become involved, causing necrosis as with other forms of scurvy. There is a noticeable tenderness, especially of the legs, which gradually increases until the use of the legs is lost. Subperiosteal hemorrhages sometimes occur and also circumscribed hemorrhage, in which separation of the epiphysis causes severe pain. Hemorrhagic swelling of the eyelid with or without exophthalmos is sometimes an important symptom.

Hemorrhages may occur over the bones of the skull, giving the face an expression of abject terror, and also in the skin and roof of the mouth as well as the eyelids and intestinal walls. Usually there is no fever, but cases have been reported with temperatures as high as 105° F.

Description of Cases.—Since recognition of the symptoms is the element of vital consequence, especially to dentists and oral surgeons, because of important indications appearing in the mouth, the author

gives full descriptions of cases to facilitate comparison and to impress the important features.

Edward C. Kirk's Cases.—"About six years ago I was asked by the late Dr. J. W. White to see a case under his care which presented a remarkable and unusual condition of the gums. The patient was an infant girl of about ten months, the child of well-to-do parents, surrounded by all the conveniences and comforts of living that ample means and intelligence could procure. The child had been weaned at about two months, owing to some imperfection in the quality of the mother's milk, and had been artificially fed with great care under intelligent medical direction from that period. A short time before I saw the case, about two or three weeks as I now recollect it, the child had shown symptoms of ill health, becoming pale, somewhat emaciated, restless and irritable, especially at night, with a tendency to cry out in its sleep, which was more or less broken and fitful. Later, the mother noticed a marked loss of power in the lower limbs, which at first the attending physicians were inclined to regard as a mere fancy on the part of the anxious mother, but the observation was later confirmed, when almost total paralysis of the lower limbs ensued; there was, however, apparently no loss of sensation. There were no pathological manifestations upon the skin, swellings or ecchymoses upon any part of the body, so far as I could learn. An examination of the mouth revealed a most distressing state of affairs. The incisors of both jaws were fully erupted, and were apparently standing in their alveoli without the least particle of attachment of gum to them. The gingival border had receded from the teeth for at least a line in distance, and presented a thickened necrotic edge, highly vascular, and bleeding at the slightest touch. Over the position of each of the first molars was a vascular tumor, the size of a half-cherry, and it in fact closely resembled one of the small and dark-colored cherries in appearance. Upon passing a bistoury into these vascular tumors a considerable flow of dark, apparently disorganized blood took place, and the erupting molar could be felt, and later seen at the bottom of the spongy vascular mass which surrounded it. The bone of the alveolar border surrounding the incisors was denuded so that it could be distinctly seen and felt with an instrument. The teeth were so loose that it seemed almost certain that they would soon be thrown out of their sockets from loss of their attachment. The case had been examined by a number of the most experienced and reliable physicians of Philadelphia, without having arrived at a satisfactory diagnosis, and the treatment was largely upon the expectant plan, with the endeavor to combat the several pathological manifestations as they arose. One specialist had diagnosticated the case as purpura, another as of metallic poisoning. The former diagnosis was found to be erroneous, because none of the general symptoms of the disease subsequently developed, while the mouth conditions grew gradually worse." Change of air and diet resulted in the complete recovery of the case.

Dr. Kirk describes another one of his cases as follows: "The onset of the attack on the incisor region was sudden. There appeared in less than two days a large, pendulous, dark red, vascular tumor from the palatal gingival border of the superior incisors, which hung down below their cutting edges, and interfered with closure of the jaws. A corresponding mass developed in relation to the lower incisors. It was noticeable in this case that areas of ecchymosis of varying size, dark red in color, very much like what we commonly know as blood blister, excepting that they were only slightly elevated above the surrounding gum tissue, appeared at the points not connected with the erupting or erupted teeth. I mention this point because nearly all writers state that the sponginess and vascularity of the gum tissue occurs only in connection with teeth, and is not seen in edentulous mouths.

"This patient was given local treatment, similar in therapeutic principle to the former one. I suggested to the mother to give the child orange juice in liberal quantities. The family physician, Dr. John H. Musser, added to this the direction to give the child the pulp of sound, ripe white grapes. In addition to this, beef juice, rare meat shredded, milk, potato, etc. The change was rapid and wonderful. The mouth trouble subsided quickly, and the whole systemic condition became normal. The child had been fed almost exclusively on proprietary foods."[1]

Other Cases.—Morse[2] divides the symptoms of his cases into three groups: "One was characterized by tenderness noticeable when the child was handled, and especially on the legs, and it gradually increased until the child ceased to use its legs. The thigh was flexed on the abdomen and the leg on the thigh. The natural mistake was to regard this as rheumatism or paralysis. The gums swelled sometimes before the appearance of the teeth, sometimes after eruption. In some instances hematuria persisted for weeks or months and led to the diagnosis of acute nephritis, tumor of the bladder, uric acid diathesis, etc. Unless treatment was given there appeared swellings in the extremities due to subperiosteal hemorrhages in the diathesis. These occurred most frequently in the lower portion of the femur, less often in the upper part of the tibia, and still less often in the lower part of the humerus. Such severe cases were mistaken for osteomyelitis and acute superficial edema."

Interesting cases have also been reported by Irving Snow[3] and Coots.[4] George Dock[5] reports a case of infantile scurvy which for two months had been treated as neuritis and anterior poliomyelitis. "The child, aged two months, was admitted to the hospital October 23, 1904. The mother had been able to nurse her for only three weeks, and then gave her equal parts of milk and water, sterilized by boiling

[1] From the Dental Cosmos, June, 1895.
[2] Med. Rec., October 19, 1908.
[3] Arch. Pediat., August, 1905.
[4] St. Louis Med. Review, March 24, 1907.
[5] Jour. Am. Med. Assn., January 27, 1906; Practical Medicine Series, 1908, vii.

for one hour. After that barley gruel and milk-sugar were added to the milk, and later a preparation of Mellin's Food, which had been heated about ten minutes was tried.

"Toward the end of August the stools contained bright red blood and then for two or three weeks they were almost black. The baby screamed when her feet and back were touched, and soon ceased to use her legs or arms or to sit up; the upper gum swelled and looked like a blood blister, and then the lower one did the same thing. A little later the upper right eyelid suddenly swelled, but the swelling subsided a bluish-red discoloration, then the left upper eyelid became involved.

"The baby now weighs fifteen pounds. Both eyes are prominent and seem to look down. The upper eyelids are slightly swollen, and the right shows a pale blue oval discoloration at the upper margin. The gum around the lower central incisors is slightly swollen, reddish purple, especially close to the teeth. The upper incisors cannot be seen, the gum over them is so swollen and ulcerated. The left arm lies extended, the right thumb is in the mouth and cannot be moved without causing pain. The wrists and lower fourths of the forearms are swollen; there is a firm swelling apparently beneath the deeper fascia. The legs and feet are extended and no effort is made to move them. The lower thirds of the legs and ankles are swollen; the swelling is firm and the skin over it glossy, bluish yellow, and pitted like orange peel. When the arms are touched the child cries.

"Orange juice and a cream and milk mixture were given as soon as the baby was admitted to the hospital and later mutton broth cooked with potato and carrot. Improvement was immediately noted."

Diagnosis.—Infantile scurvy is differentiated from rheumatism because the latter affection never occurs at this early age, and the swellings are over the joints and not over the epiphysis. Rheumatism is never accompanied by bleeding gums or hematuria. It is distinguished from periostitis and osteomyelitis, because in those affections the tenderness and swelling are limited in extent and accompanied by signs of acute inflammation, also because of its bleeding gums; from infantile paralysis, because of the sudden onset of that affection; from difficult dentition, by difference in the appearance of the gums; from traumatism and hip disease, because of the general symptoms that accompany scurvy. The final test, however, is the improvement of the patient upon administration of orange or lemon juice and other changes in diet.

Prognosis.—The prognosis is good if the disease is recognized early and corrective measures are temporarily instituted.

Treatment.—As already indicated, orange or lemon juice, about two tablespoonfuls daily, fresh beef juice in such quantities as may be administered without disturbance of the child's digestion, plenty of fresh air and good general care with careful readjustment of the food

formula. Soothing, mildly astringent, antiseptic mouth washes are required for the treatment of the mouth and gums. Immobilization of the limbs is sometimes necessary to relieve pain and tenderness.

BLASTOMYCOSIS CUTIS.

Blastomycosis is a chronic infectious inflammatory disease caused by a pathogenic fungus.

Etiology.—Blastomycetes gain entrance to the tissues often through some external wound. When these have a pathogenic tendeney, their budding leads to the formation of miliary abscesses which frequently require microscopic and cultural examination to differentiate from tuberculosis.

Symptoms.—The papule which marks the beginning of the disease becomes covered with crust, enlarges, and assumes a warty appearance. The papules enlarge until they sometimes cover quite considerable surfaces which are elevated, have sharply defined borders, and as they become older lose the appearance of dryness and become more or less softened with pus at the base. The skin surrounding these is filled with tiny abscesses, so small as to be barely visible to the naked eye. The pus that exudes when they are punctured contains the yeast organism. It quite frequently affects the face, and may therefore be found upon the lips. Its resemblance to syphilis is often marked.

Prognosis.—Its chief danger of fatal termination lies in the development of pyemia or some form of septicemic complication.

Treatment.—The treatment consists in excision, the application of *x*-rays, administration of large doses of potassium iodide, and copper sulphate applied locally.

ERYSIPELAS.

Erysipelas is an acute specific inflammation of the skin and subcutaneous tissues characterized by pronounced general symptoms.

Etiology.—Its cause is generally admitted to be the Streptococcus erysipelatis of Fehleisen, although other organisms are often present. Wounds and even slight abrasions or imperfections in the skin and mucous membrane surfaces give opportunity for entrance of the germs. Uncleanliness, alcoholism, general debility, diseases of the kidney and of other vital organs may be predisposing causes.

Symptoms.—Its symptoms are usually ushered in by a distinct chill followed by fever (usually 103° or 104° F.), headache, and sometimes nausea. The degree of fever, as with other infections, is usuall ayn indication of the character of the disease. Its first appearance is usually in the neighborhood of the infection. Otherwise the mucocutaneous junctions, such as the nostrils, angles of the mouth, eyelids, and ear, are the points of onset. It begins with a rose-red spot, which spreads peripherally and sometimes very rapidly until considerable surfaces may be covered, when the blush-like appearance may change to various hues of yellow, brown, or darker shades.

The skin surface is hot, tender, and glazed, with tendency to become indurated and rough to the touch. The swelling may be slight, or if in the neighborhood of the eyelids or other loose skin surfaces, is sometimes a very marked symptom. As the disease progresses, there usually is formation of vesicles and blebs which may be filled with clear serum, be purulent or in severe cases hemorrhagic. The lymphatic ganglia sometimes show marked effect of infection. The subjective symptoms are burning, itching, local tension, and tenderness to pressure. Usually such attacks run their course in less than two weeks, but unfavorable conditions may cause their prolongation for a much longer period.

A form of this disease which disappears from one region of the body and reappears in another is called *erysipelas migrans* or *ambulans*.

Mucous Membrane Surfaces.—Although chiefly affecting the skin surface, erysipelas may spread to the mucous membrane surfaces of the nose, pharynx, throat, and other parts. When the pharynx is affected there is usually marked swelling of the submaxillary and cervical glands, a burning sensation in the throat, accompanied by intense dryness and difficult breathing. Edema in these cases is a serious complication. Marshall[1] reports a patient dying from suffocation in this condition when associated with dento-alveolar abscess. The mucous membrane of the mouth, as well as the throat, assumes a dark red color, vesicles appear upon its surface with general swelling. Glossitis is frequently a marked symptom. *Erysipelas neonatorum* is a form of the disease affecting newly born children. It is quite commonly fatal and undoubtedly due to infection. Its first manifestations appear in the region of the umbilical cord. The symptoms are marked, progress rapidly, and usually terminate in collapse and death in the course of a few days.

Diagnosis.—Facial erysipelas is distinguished from erythematous eczema, although in the latter there may be great swelling and closure of the eyes, by the absence of fever and constitutional symptoms. In erysipelas the border is more sharply defined.

Prognosis.—The prognosis is good unless abscesses or gangrene develop, or when age, habits of life, or constitutional conditions are unfavorable. In such cases there may be fatal termination.

Treatment.—Remove predisposing condition by disinfection of wound surfaces and building up the general health. Give light, easily assimilated, nourishing diet.

Local application of ichthyol ointment, such as—

℞—Ichthyol 3j–ij
Lanolin,
Adipis benzoat. . . . . āā 3iv
Sig.—Apply to affected surface. (Schamberg.)

or lead water and laudanum may be grateful in relief of local irritations. Local applications of a hot saturated solution of magnesium sulphate are of decided value.

[1] Surgery of the Face, Mouth and Jaws, p. 127.

CHAPTER V.

DISEASES OF THE NERVOUS SYSTEM AFFECTING THE BUCCAL REGION.

Because of the wide distribution of such affections it is difficult to take up the consideration of all nervous diseases that may be directly or indirectly manifested in this field, but it is essential that at least a measure of consideration be given to neuroses which through direct connection with the parts in this anatomical situation, or because of oral symptoms that may be of diagnostic value, should be understood by those whose practice favors their observation during early stages, even though the actual seat of the disease may be in some other division of the body.

Injuries of Nerves.[1]—Nerves are frequently injured, being exposed in their long course. The pathological effects of such injury and the symptoms produced are somewhat different from those of neuritis, hence they require a separate consideration.

Present knowledge is chiefly based upon experimental division of nerves in animals, but notwithstanding controversial opinion, it is assumed that the process in man is much the same as in animals.

The cut end of a divided nerve becomes swollen into a bulbar extremity by growth of connective tissue and by the development of fine nerve fibers in process of regeneration. This forms a very sensitive scar. Whether a true union of the divided ends ever occurs is still a matter of dispute.

The Process of Regeneration.—Ranvier and his followers affirm that the new nerve is wholly a product of the central end of the injured nerve, growing out from it and making its way along the track of the peripheral end, which takes no active part in the process. This rule has recently received confirmation by the studies of Harrison and Mayer, and more recently Ballance and Stewart have affirmed to the contrary that the regeneration goes on in the peripheral end of the cut nerve, segment by segment being formed successively or simultaneously, the new nerve being built up by the union of each distal segment with one lying centrally to it, until the process is complete. All surgeons believe that function may be rapidly resumed after suture of freshly divided nerves with rapid restoration of sensation.

NEURITIS.

Classification.—The forms of neuritis may be described as: *Localized,* when the nerve is inflamed in the short portion of its course; *Disseminated,* when affected at many different parts; *General,* when diseased

[1] Starr, Nervous Diseases, Organic and Functional, Part II, 4th ed., pp. 159 to 173.

in its entire length; *Ascending* or *Descending*, according to the direction in which disease makes progress, and *Migratory*, with tendency to appear in different parts of nerve distribution.

Multiple neuritis, polyneuritis, or *peripheral neuritis* is a general disseminated inflammation upon both sides of the body and generally affecting all the nerves of the limbs, particularly in their terminal branches. The affection rarely, if ever, extends as high as the nerve plexuses.

Etiology.—Neuritis may occur secondarily to inflammatory changes in other parts, as with periostitis or abscesses. Syphilitic deposits in the nerves, tubercles in the nerves, cancer or other neoplasms along the nerves, may cause a proliferation of the connective-tissue elements or a true diffuse inflammation.

It may result from traumatic or other injury to the nerve. Among other underlying causes are constitutional diseases, blood disorders, inflammatory changes in other parts, as from periostitis, abscess, etc., septic infection, auto-intoxication, and other toxic effects, from lead, alcohol, and other poisons.

Multiple neuritis is due to general constitutional states. La grippe is a frequent cause. It is more common in males than in females, and may affect all ages. The diphtheritic type is more commonly seen in children. Heredity appears to play little or no part in the causation, excepting insofar as the general tendencies to gout, rheumatism, diabetes, carcinoma, arterial sclerosis and tuberculosis may be said to be hereditary.

Pathology.—An inflamed nerve is red and swollen, lacking in its natural surface luster, and no longer firm and smooth to the touch. Its vessels are congested, and there may be hemorrhage within its sheath. If the process has been in progress for some time there may be bulbous swellings on the nerve resulting from connective-tissue infiltration, or the nerve may be markedly atrophied. A section of the nerve as viewed by the microscope shows a distention of the vessels, an infiltration of the endoneurium with small cells, and a thickening of the connective-tissue elements. Pathological distinctions are marked by the following forms of the disease.

Parenchymatous Neuritis.—At the outset the myelin sheath appears slightly swollen or else homogeneous, and from a difference of refractive power is less translucent.

Interstitial Neuritis.—Interstitial neuritis shows the nerve to be congested, swollen, thicker than normal, and lacking in luster, or to be yellow and irregular and swollen by the accumulation of pus and serum and reduced to a nerve connective-tissue strand.

Segmental Periaxillary Neuritis.—A toxic neuritis from lead or alcohol poisoning in which the degenerative process is not uniform throughout the entire length of the nerve fiber.

Symptoms.—The symptoms of neuritis are pain and tenderness along the course of the nerve. The latter is its distinguishing feature.

Severe attacks of neuralgia accompany or follow la grippe in about 15 per cent. of the cases, and are an evidence of direct action of the poison upon the nerve trunks. Thus trigeminal neuralgia, occipital neuralgia, intercostal neuralgia, and sciatica frequently develop and some run a very severe and long course. They are occasionally bilateral and symmetrical, which is rare under other conditions.

Many cases of local neuritis appearing simultaneously in one or in several nerves in the body have been observed after la grippe. Any of the cranial or spinal nerves may be involved.

Prognosis.[1]—The prognosis in neuritis, as a rule, is good. There is a spontaneous tendency to regeneration in a nerve that is injured or that has been affected by inflammation, and while this progress toward recovery is usually slow, yet eventually it becomes complete and all functions of the nerve are restored. Recovery is impossible if a union between the several ends of the nerve is prevented by the interposition of a callus, or intervening connective-tissue scar; but after such obstructions are remedied by surgical treatment, regeneration takes place, even though the obstruction may have persisted for many months. Spontaneous recovery, unless the nerve is put in normal condition by being freed from scar tissue, many not occur.

Bruns[2] has called attention to the ultimate results in injuries of the nerves and of the plexuses, and has shown that while two-thirds of his cases of nerve injury recovered, only about one-quarter of the cases of injuries of the plexuses were cured.[3]

Treatment.—In the treatment of injuries and wounds of nerves or in spontaneous neuritis the first and most important object is to secure the possibility of regeneration by establishing the continuity of the injured nerve. Clean-cut ends of the nerve may be brought together and carefully united, as in Fig. 96, or if laceration has taken place with loss of continuity, a flap may be made from both ends and these elongated nerves then united (Fig. 97). Inserting the ends within a tube of decalcified bone or a non-absorbable celloidin tube as advocated by Sweet, may serve to direct the regenerating fibers outward toward the distal end and prevent the regenerating nerve from becoming entangled in an obstructing mass of connective tissue. Ochsner has secured good results with catgut extensions to promote union, even when a distance of half an inch or more was to be bridged.

In cases of spontaneous neuritis from cold, etc., it is only necessary to maintain the parts in a perfectly quiet position, and, if possible, to reduce congestion in the inflamed nerve. This may be done by the use of a counter-irritant, of which the actual cautery is probably the best. Light touching with a Paquelin cautery along the course of the inflamed nerve will often relieve intense pain and reduce the congestion which attends spontaneous neuritis. Small mustard plasters are also of service.

[1] Starr: Nervous Diseases, Organic and Functional, 4th ed., p. 178.
[2] Neurol. Cent., November, 1902.
[3] Kennedy: British Med. Jour., February 7, 1903.

Local applications of heat are often very grateful in painful conditions of neuritis, and usually more agreeable than cold; poultices or packing the affected limb in cotton-wool covered with oiled silk may

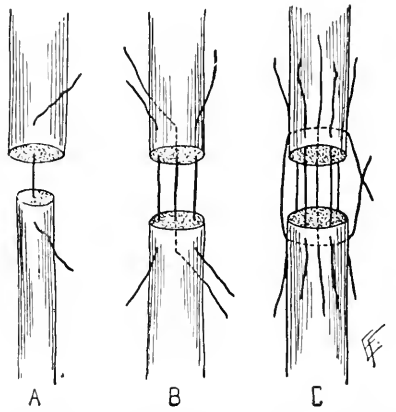


FIG. 96.—Methods of nerve suturing: *A*, *B*, sutures passing through sheath and part of nerve; *C*, sutures through sheath, reinforced by relaxation suture through entire nerve. (After Brewer.)

be of service. In more severe cases, with intense pain which prevents rest at night, it may be necessary to use analgesics. Antipyrine, 10 grains; acetanilid, 3 grains; exalgin, 3 grains; or salophen, 10 grains,

FIG. 97.—Nerve suturing, with lengthening. (After Brewer.)

may be used every two or three hours; or a combination of these with a small amount of codein if the pain is very persistent. The following formula is generally used:

℞—Phenacetin . . . . . gr. vj
Acetanilid . . . . . gr. iij
Codein . . . . . gr. $\frac{1}{4}$
Caffein . . . . . gr. ij
Sacch. lactis . . . . . gr. v
Mix and triturate.
Sig.—One such powder every three hours.

TUMORS OF THE NERVES.

Neuroma.—Any form of tumor (fibroma, angioma, sarcoma, etc.) may develop within a nerve sheath or upon it and thus produce an apparent tumor of the nerve. In such cases the nerve fibers may pass through the tumor or may be dissected apart by it and pass around it. Such tumors have been termed false neuromata, for they are not composed of nerve cells or fibers. But the fibers may become com-

pressed by the newgrowth and undergo degeneration. The symptoms and course of the case under such conditions will be expressed according to the character of the affected nerve.

Starr[1] gives the following description:

"Neuromata, or tumors consisting of nerve fibers, first described by Virchow, are a rare form of tumor. The fibers of which they consist may be medullated or non-medullated; nerve cells are not found in such tumors; connective tissue exists in greater or lesser degree, so that some tumors are neurofibromata. There appears to be a tendency for such tumors to be multiple, and in the large majority of recorded cases hundreds of minute tumors have developed. Occasionally the tumors have been large, but usually they are the size of a pea. When they appear on the sensory nerves of the skin they are easily felt and are usually tender. Under these circumstances they have been called 'tubercula dolorosa.' I have seen a patient with more than a hundred such tumors distributed over the entire body. Hoggan has shown that some tumors of this description were adenomata of the sweat glands. That some congenital tendency to the multiplication of nerve fibers is at the basis of this affection is proved by the fact that many of the cases reported have been in children. Thus in the so-called plexiform neuroma of the fifth nerve the disease is usually congenital and other nerves have been affected later in life. The tumors obtain a certain size, and then, as a rule, cease to grow; the condition remains permanent until death from some other cause.

"In the majority of cases no symptoms are caused by neuromata, as the nerves on which the tumors develop are not affected by the growth. The tumors may be felt and may be tender to pressure. They are not subject to treatment and cannot safely be removed, as they are so numerous, and as the nerves may be cut. Occasionally pain, hyperesthesia, and numbness are caused by neuromata.

"There is one form of neuroma which, however, requires special mention. It is the neuroma which develops on the cut end of a divided nerve, either after an amputation or after an injury without union. Such a neuroma may be extremely painful to the peripheral termination of the nerve, and also cause spasms in the muscles related to these terminations. In such cases excision is imperative, but recurrence is not infrequent.

"In one patient under my observation who suffered from great pain referred to the toes for many years after an amputation of the leg above the knee, excision of the neuroma on the sciatic failed to give relief. A portion of the sciatic nerve in the thigh was then excised, but this also failed to stop the pain. In this case it seemed probable that atrophic changes had occurred in the spinal cord, such as are known to follow amputations, and that these had involved not only the anterior horns, but also the sensory columns."

[1] Nervous Diseases, Organic and Functional, 4th ed., p. 193.

DISEASES OF THE SPINAL CORD, ETIOLOGICALLY, SYMPTOMATICALLY, OR OTHERWISE RELATED TO THE REGION OF THE MOUTH, FACE AND JAWS.

The following diseases deserve the special consideration of all who undertake the treatment of buccal affections, because (1) the face and mouth so frequently evidence developmental imperfections which are indicative of neurotic tendencies that predispose to spinal diseases. (2) Direct and reflex irritations from developing teeth and other causes sometimes give rise to disturbance through trigeminal irritation, which may increase susceptibility to other nerve affections. (3) In many of the spinal diseases the etiological character of which is not fully understood, it will be noted that infection and disturbance of the digestive tract are among the constantly recognized important factors, therefore the causal relation of pyogenic microörganisms of the mouth and diseased conditions directly or indirectly connected therewith, including malnutrition, must receive due consideration. (4) Symptoms affecting the facial, buccal, and lingual regions are of vital interest because they indicate the upward progression of spinal diseases that by giving rise to bulbar paralysis point the way to hopeless prognosis, without due recognition of which the true disease might be confused with affections of the cranial nerves or brain of vastly different character. (5) There is a significant developmental relation between atrophic and hypertrophic tendencies commonly associated with spinal affections and deformities, as noted in the teeth, palate, jaws, and bones of the face, that deserves much greater attention than it has yet received with reference to both diagnosis and treatment of oral and facial deformities.

Syringomyelia or Glossis Spinalis.—This is a central myelitis and is marked by the formation in the spinal cord of a fissure or canal which is usually posterior to the central canal and preceded by hyperplasia, degeneration, and softening of the neuroglia.

Etiology.—Without exact knowledge of a true cause, the commonly accepted factors pertaining to the etiology of this affection are based chiefly upon pathological manifestations. These indicate that it may be due (*a*) to congenital defects of development, (*b*) disintegration of the spinal cord from inflammatory causes, (*c*) retrograde metamorphosis caused by impairment of tissue nutrition by obstruction to the circulation, (*d*) destruction of the cord by hemorrhage.

Bacterial infection is quite generally recognized as an important etiological factor.

Symptoms.—*Analgesia.*—There is a loss of the sensation of pain and temperature with preservation of the tactile sense in the analgesic area. The affected part of the body will necessarily depend upon the extent of the lesion of the cord. Usually the hands are first affected because the cervical portion of the cord is most commonly the point of origin. By reason of the fact that the sense of touch is seldom

influenced, patients are frequently unconscious of the anesthetic condition of the affected parts until it is demonstrated that there is no pain felt from pricking, cutting or burning. Sometimes the sensation of cold is recognized and that of heat much impaired, or *vice versa*.

Trophic Disturbance.—Trophic disturbances occur through injury to which there is a predisposition on account of the insensibility to pain of the affected area of the body and because of the impairment of nutrition through affection of the trophic centers of the spinal cord. Abnormalities of the skin are noted in these cases, varying from slight surface changes, to ulcers, gangrene, and graver conditions of this character. The extremities and joints are also frequently affected, particularly the shoulder, elbow, and wrist, in contradistinction to tabes, which more often affects the lower extremities.

Muscular atrophy attended by paralysis affects many of these patients. Extension of the disease to the medulla may cause any of the cranial nerves to become affected. The involvement of the motor portion of the fifth and glossopharyngeal nerves, as in syringobulbia or the lower portion of the nucleus of the seventh nerve, sometimes gives rise to intense atrophy of the tongue, disturbance of speech, facial paralysis, and other symptoms in the area of distribution of these nerves.

Diagnosis.—Recognition of the three characteristic symptoms of this disease, when all are sufficiently developed, serves to distinguish it from other affections causing bulbar paralysis, locomotor ataxia, general myelitis, tumors of the cord, and other spinal diseases.

Treatment.—There is no method of treatment which may be relied upon to check the progress of this disease. The *x*-rays, radium, electricity, and similar measures are recommended. Relief of symptoms is about all that can be done with benefit in a therapeutic or surgical way.

Anterior Poliomyelitis; Acute Anterior Poliomyelitis; Infantile Paralysis; Acute Atrophic Spinal Paralysis, or Retrogressive Paralysis.—Poliomyelitis is an acute disease characterized by sudden, complete loss of power in one or more limbs, usually in the legs, followed by rapid atrophy of the paralyzed muscles and imperfect growth of the limb, with slight pain and no permanent sensory disorder. It occurs chiefly among children, and may occasionally affect older persons. It may be of sporadic or epidemic form. E. Farquhar Buzzard[1] suggests the use of the term acute poliomyelitis instead of acute anterior poliomyelitis, because the latter term is misleading, "since it describes the limitation that is at times incorrect." The word infantile is also objected to because the disease is within any of the first four decades of life.

Etiology.—At the time of the epidemic appearance of poliomyelitis in Norway in 1903 to 1906, F. Harbitz and Osheel, of the Pathological Institute of the University of Christiania, stated that it seemed to be an infectious disease with living virus, possibly diplococcus. Epidemics in New York and other localities in 1907 seemed to corroborate

[1] Practical Medicine Series, 1907, x. 143; Lancet, March 16, 23, and 30, 1907.

this conclusion. It has long been known, as stated by Buzzard, that "its essential lesion is an inflammation of the interstitial tissue of the central nervous system due to the presence of microörganisms or other toxins, probably in the blood (but possibly in the lymph) circulating within the system."

In 1910 the United States Public Health and Marine Hospital Service Report stated that it had been proved "by work at various laboratories, notably the Rockefeller Institute for Medical Research, that anterior poliomyelitis is transmissible to monkeys; that the causative organism is a 'filterable virus;' that not only the central nervous system, but also the secretions of the nose and mouth are infective, and that the most probable avenues of infection are the respiratory and digestive tracts. A distinct immunity has been demonstrated in recovered animals, holding out the hope, as yet far from realization, of a possible specific therapy."[1]

In 1913 Flexner and Noguchi reported the finding of a microörganism which they described under the term globoid bodies. During the epidemic of 1916 in the United States, George Mathers and Ruth Tunnicliffe, Nuzum and Herzog, and Rosenow, Towne, and Wheeler, isolated a coccus, which according to their researches caused experimental poliomyelitis. Rosenow and Towne hold that the small globoid microörganisms which Flexner and his followers believe to be the cause of poliomyelitis were, as a matter of fact, the result of the breaking down of large diplococci which have been isolated from the central nervous tissues of each monkey affected with poliomyelitis.

Simmons sums up the situation by stating that "the fact remains that a very interesting coccus has been found in the brain and spinal cord of patients who have died of poliomyelitis, but its relation to the disease is not yet determined."

Symptoms.—*Sporadic Cases.*—Fever may rise rapidly to 102° or 103° F., or remain at about 101° for several days and then sink to normal in the course of about six or seven days. There may be convulsions and delirium, vomiting, diarrhea, and general malaise, with considerable pain in the back, body, and limbs. The onset of the paralysis may be sudden or appear after several days. Rigidity of the spine and neck may occur as in meningitis. When the other symptoms subside the paralysis remains. The paralyzed muscles undergo atrophy with marked change in the size of the limb. In some cases the febrile symptoms do not appear, the paralysis occurring while the child is apparently in good health. When the cranial nerve nuclei are invaded the symptoms which ordinarily appear in the extremities are evidenced in facial palsy, paralysis of the larynx and tongue, strabismus, etc. Deformities of the bones and joints occur as sequelæ of the disease.

Epidemic Cases.—The symptoms in this form of acute poliomyelitis are similar to those occurring in infectious diseases. There is an initial

[1] Annual Reports United States Public Health and Marine Hospital Service, 1910, p. 33.

chill, high fever, vomiting, malaise, severe pains in the back and limbs, with occasional rigidity of the spine and retraction of the head as in meningitis. The fever usually lasts from five to ten days, and about the third or fourth day the paralysis is suddenly manifested. The paralysis may extend to the neck, throat, face, and eyes, and present all the symptoms of bulbar palsy.

Diagnosis.—There is usually little difficulty in recognizing the disease with evidence of the paralysis and history of the initial symptoms.

Prognosis.—The prognosis is always grave. Death sometimes occurs during the acute onset. This rarely happens, but the resulting paralysis is quite permanent. In the epidemic cases fatal results are more frequent and usually occur from paralysis of the respiratory muscles.

Treatment.—In the acute stage the child must be kept in bed and counter-irritation should be applied along the spine. The febrile condition must be allayed by sponging with tepid water and alcohol, light nourishing diet is required, and laxatives, such as castor oil, are given to assist elimination of gastro-intestinal poisons that may be present. Ergot in 10-minim doses of the fluidextract for a child, aged two years, is recommended to be given every four hours, with 2 minims more for each additional year. Iodide of potassium, 1-grain doses, salicylate of strontium and urotropin, 1 grain every six hours during the first ten days, are all recommended.

The intraspinal injection of human serum from recovered and convalescent cases of the disease seems to offer the best promise of success in treatment.

Amoss, Chesney, and Draper[1] report and recommend its use.

Antipoliomyelitis horse serum is reported to have protective and curative properties against the virus of poliomyelitis.[2]

C. W. Wells recommends the intravenous injections of immune serum in doses of 50 to 100 c.c. or more daily, and following intravenous or intramuscular injections of serum, spinal fluid should be withdrawn. He advocates an early diagnosis of the disease and an early administration of the serum.

After the acute symptoms have subsided the paralysis and atrophy require such treatment as massage, hydrotherapy, and electricity, and as the disease progresses, the use of mechanical appliances for support of the deformed parts. Operations upon the muscles, tendons, and nerves, especially nerve grafting, give promise of overcoming, to some extent at least, the effects of the paralysis. Much progress is now being made in the direction of the restoration to usefulness of children deformed by this affliction.

Neutralization of Virus of Poliomyelitis.—The results of fifty-six experiments by Amoss and Taylor showed that washings of the nasal and pharyngeal mucosa possess definite power to inactivate or neutralize the active virus of poliomyelitis. This power is not absolutely fixed,

[1] Jour. Am. Med. Assn., May 12, 1917, p. 1436.
[2] Neustaedter and Banzhaf: Jour. Am. Med. Assn., May 26, 1917, p. 1531.

but is subject to fluctuation in a given person. Apparently inflammatory conditions of the upper air passages tend to remove or diminish the power of neutralization. Mouth disinfection should therefore be recommended in all growing children as a prophylactic measure and rigidly maintained during the treatment of such cases.

Chronic Anterior Poliomyelitis; Chronic Atrophic Paralysis; Progressive Muscular Atrophy.—This is a condition of paralysis with atrophy.

Etiology.—The etiological factors of this affection appear to be closely allied to those already enumerated for acute anterior poliomyelitis. Injury, overwork, exposure to cold, and infectious diseases are the causes most frequently reported. Notwithstanding this, it is not yet fully established whether the disease is inflammatory or degenerative in character.

Pathology.—There is a slowly advancing atrophy in the primary motor neurons of the cord, the cell bodies, dentrites, and axons degenerating together. These cells lie in groups in the anterior horns and the central gray matter, and the lesion affects these groups in different degrees.

Symptoms.—The symptoms are those characteristic of affections of the spinal cord, advancing paralysis affecting one leg, then the other, the feet, hands, etc. In the last stage, as the disease extends, bulbar palsy ensues with paralysis and atrophy. The muscles of the face tongue, and throat become paralyzed and atrophied with difficulty of speech, swelling, etc.

Prognosis.—Death usually results from respiratory or bulbar paralysis and the prognosis depends upon the possibility of its arrest before these symptoms ensue. Rapid course and recurrence are both unfavorable.

Treatment.—Good hygienic care and food, moderate exercise, avoidance of fatigue, the correction of any associated disease or etiological factor that may exist. Massage and electricity are sometimes recommended, especially mechanical massage; strychnin and similar remedies are occasionally administered to advantage.

Amyotrophic Lateral Sclerosis.—This disease is a chronic progressive form of spinal paralysis characterized by the symptoms of progressive muscular atrophy. It was formerly believed to affect almost exclusively the arms and legs, but is now known to include all the motor elements of the nervous system.

Etiology.—The causes are not definitely known. Presumably congenital weakness of the motor elements of the nervous system renders such individuals particularly susceptible to cold, overexertion, various forms of poisoning, such as alcohol, arsenic, lead, mercury, the toxins of infectious diseases, auto-intoxication, rheumatism, gout, diabetes, etc.

Symptoms.—Stiffness of the muscles, with increased reflex excitability, followed by atrophy and paralysis of the extremities, is sometimes associated with bulbar symptoms. Occasionally the affection

begins with bulbar palsy, and in these cases there is disturbance of speech due to paralysis of the muscles of the tongue, lips, mouth, and palate. Among other symptoms are fibrillary twitchings of the tongue, which sometimes protrudes from the mouth, difficulty in swallowing, attacks of choking, with return of fluids through the nose on account of paralysis of the soft palate, paralysis of the facial muscles, saliva flowing from the corner of the mouth, etc. There is increased muscular irritability, so that percussion of the masseter and other muscles of the jaw will produce a sudden spasmodic contraction.

Starr[1] describes the following case, which gives a good clinical picture of the disease. "I. D., aged forty-two years, had been much exposed to wet, to extreme heat, and to cold in his occupation, and had suffered from muscular rheumatism for years. In February, 1889, he noticed double vision, due to a lesion of the left external rectus muscle, and ptosis, which first affected the left eye and then the right eye. The ptosis gradually subsided, but the strabismus remained. In March, 1889, his speech became thick, and in April he began to have difficulty in swallowing, fluid food coming out of his nose. In May he noticed difficulty in chewing, and his friends saw a change in his facial expression due to a weakness of the facial muscles. During all this time he felt an increasing weakness in all his movements. His neck had become stiff and his head tended to fall forward and was held with chin projecting beyond the line of the body. On several occasions after March, 1889, he had fainting attacks, in which he became pulseless and pale. In June, when I saw him, he was thin and pale, clear in his mind, but feeble in all movements. His eyes were both turned in a little and his left eye looked up. He had corresponding double images, but no nystagmus, and his pupils were normal. His optic nerves were normal, but the muscles of mastication were atrophied, did not react to faradism, and were so weak that chewing was impossible. He moved his jaw with his hand and gave it constant support. His face was expressionless; he could not whistle, food collected in his cheeks, but all his facial muscles could be slightly moved, and reacted to faradism. His palate was paralyzed, and it was to this cause that his defect of speech was due, as the tongue was not paralyzed or atrophied. His neck muscles were weak. There was an atrophic condition of the thenar muscles of the forearm. The deltoids and muscles of the arms were in good condition. His gait was slow and feeble, but not spastic; but his knee-jerks were exaggerated and ankle-clonus was obtained. He controlled his spincters well. During the following year his paralysis increased in his arms and legs, his inability to talk became more apparent, and in August, 1890, he choked to death."

Diagnosis.—The symptoms in some respects are almost self-evident, because in muscular dystrophy there are no muscular symptoms or fibrillary twitchings. Bulbar paralysis alone does not have spinal

[1] Nervous Diseases, Organic and Functional, 4th ed , p. 390.

symptoms. Absence of sensory disturbances or trophic affections distinguishes it from syringomyelia. Tumors of the spinal cord have sensory symptoms as well as paralysis and muscular atrophy, as does also myelitis.

The effect of this disease upon muscular action in the various anatomical regions is quite similar to that of progressive muscular atrophy. Although positive and radical lines of symptomatic distinction do not seem to be fully warranted, the following distinguishing characteristics are in a general way conclusive according to some writers, notably Williamson:[1]

AMYOTROPHIC LATERAL SCLEROSIS.	PROGRESSIVE MUSCULAR ATROPHY.
1. In favor of amyotrophic lateral sclerosis would be a spastic condition of the legs, spastic gait, scraping of the toes in walking, rigidity of the legs on passive movements, increased knee-jerks, ankle-clonus, and the extensive type of plantar reflex, Babinski's reflex.	1. These symptoms not so marked.
2. Symptoms of bulbar paralysis would be in favor of amyotrophic lateral sclerosis.	2. These symptoms not so marked.
3. Runs more rapid course. Usually terminates fatally in from one to four years.	3. Tendency to become chronic, may continue for ten, fifteen, or twenty years.
4. Paresis may occur without muscular atrophy.	4. Muscular atrophy primary symptom.

Prognosis.—The prognosis is exceedingly doubtful. Cases of recovery have been reported, but are rare.

Treatment.—Therapeutic aid must rely upon efforts to build up the general tone of the system, massage, electricity, good hygienic care, rest.

Muscular Dystrophies.—These forms of paralysis appear in early life, and are regarded as due to muscular and not nervous disease.

Etiology.—The disease is recognized as one of development, presumably an inherent tendency toward weakness of certain muscles indicating insufficient developmental vigor in these parts, or the trophic influences to which they are subject. Many cases have been reported in which the family history showed other members of the family having tendency to muscular dystrophy. On the other hand, there have been sufficient cases in which no hereditary influence could be recognized to eliminate it as a constant factor. Occasionally infectious diseases, unusual muscular effort, traumatism, exposure to cold and similar agents, have appeared to be influential.

Symptoms.—The symptoms appear in early life, become arrested in the course of its progress with tendency toward improvement, or to continue until there is complete muscular destruction.

The different forms of these affections bear the names of their first

[1] Edinburgh Med. Jour., April, 1907.

observers, as *Duchenne type*, pseudohypertrophy, and apparent disproportionate increase in the size of muscles usually beginning with the calves of the legs, which is rarely an increase of fat cells with atrophy of muscular fibers. The *Erb type* of juvenile dystrophy, usually beginning between the ages of twelve and sixteen, affecting primarily the muscles of the shoulder, which become hypertrophied but weakened, and by gradual progress affecting the muscles of the body. *Landouzy-Déjerine* dystrophy, also usually developed in early childhood, but occasionally appears in adults. Its principal feature is muscular atrophy of the face, which begins with the orbicularis oris, extends to the risorii, to the levator menti, and to the other muscles of the face associated with the mouth. In consequence the lips cannot be firmly closed, the mouth is habitually open with the lips projecting forward, the so-called "tapir mouth." Quite naturally there is more or less difficulty in speech, control of saliva, drinking, and other acts which depend upon the lips. There are no fibrillary twitchings, no disturbance of sensibility, and there is gradual decrease of mechanical muscular excitability.

Prognosis.—The prognosis in muscular dystrophy is generally regarded as unfavorable, and it is expected that in some forms of the disease there will be a continued although not rapid progress, which by extension from muscle to muscle will ultimately bring about a condition of complete paralysis. The hopeful feature lies in the fact that this does not always occur, and that after a time the progress of the disease ceases. Death usually occurs through the development of some complicating condition or paralysis of the respiratory apparatus.

Treatment.—The treatment advised is in the nature of general measures to improve health and nutrition, fresh air, well-selected, nourishing food, exercise, massage, with avoidance of unusual fatigue.

The author has deemed it important to include muscular dystrophy among the affections which bear an important relation to the oral and facial regions, because in a large number of cases under his care and observation irregular dental arches, high, narrow palatal vaults, and the nasal defects which are usually associated in individuals so affected have been coincident with asymmetrical muscular development in other parts of the body. Whether these cases should have been properly classified under any of the several forms of muscular dystrophy is perhaps to some extent questionable on account of incomplete history and diagnosis. But there can be no doubt of the fact that the factors leading to irregular or imperfect development in other divisions of the body can be in like degree influential in making for irregular development of the jaws and face. Again, it is equally true, and fully demonstrable from innumerable cases in practice, that with proper expansion of the palatal arches by separation of the upper maxillæ at the median suture, and the widening of the nares invariably following this procedure, the first result is an improvement in nasal respiration

and increased healthfulness of intranasal tissues, with attendant marked general improvement of health, nervous and other governing influences. When supplemented by proper form of the dental arches and correct occlusion of the teeth, it gives at least reasonably good promise for the betterment of developmental influences. We have, therefore, in the region of the mouth and jaws not only an index of individual tendency to imperfect or asymmetrical growth, but a promising opportunity for directly benefiting predisposing conditions, and this is certainly worthy of consideration in every instance.

Without doubt many cases which dentists treat for the correction of dental irregularities are merely expressions of some more general affection. Although the regulation of the teeth does have a wider beneficial influence than is usually contemplated when such procedures are undertaken, a more general examination of the developmental conditions of such patients would undoubtedly lead to detection of many diseases at an early stage when curative treatment could be successfully applied and the influence of mouth treatment be much extended in its beneficial aspect.

Just where the line of demarcation should be drawn in every instance between muscular atrophy, which notes the beginning of a progressive condition that may be expected to lead on to paralysis, and one of such character that its progress will be arrested in natural course without necessarily causing a state of helplessness and endangering life, is often difficult to decide. It must also be more or less a matter of speculation, when the progress of the disease has ceased during treatment with apparent restoration or increased usefulness of the affected parts, to determine just how much or how little the actual remedial measures may have accomplished. While the author fully appreciates these facts, he believes (1) that the centers governing trophic changes, especially when these show pathological alterations in the region of the face and jaws, may be directly benefited by maxillary separation, which, as already stated, relieves nerve tension and compression in the region of the jaws and teeth, widens the nares, and thus makes possible better respiration; (2) that in young persons it is only reasonable to expect the effect of expansion in the lower regions of the face to favor also greater freedom of growth in the higher structures at the base of the skull in which are situated the larger foramina through which the cranial nerves and their important accompanying vessels emerge, compression of any one of which would be capable of causing both local and general disturbances of far-reaching character; (3) that it is not impossible for this influence to extend still higher until it could affect the form of the sella turcica in which the pituitary body is situated and thus reach the hypophysis which is now recognized as an influential factor in aberrations of growth; and (4) that in this way the vegetative nervous ganglia of the nose and respiratory tract are stimulated as the nares become enlarged, and nasal respiration secured. In due course the ciliary, otic, and sphenopalatine ganglia are affected,

and through these the balance of control between the sympathetic and the vagus systems is regulated in such manner as to establish a widely beneficial result. Thus the endocrin (so-called ductless gland) organs become included with other corrective influences on nervous, circulatory, digestive and glandular physiological activities. Without desire to urge unduly what in our present state of knowledge must be admitted to be largely theoretical, the author presents brief descriptions of two of his cases (Figs. 98, 99, 100 and 101). It will be seen that they bear indications of dental and facial irregularity of development of not uncommon type, yet further study of their histories and symptoms reveals the fact that they undoubtedly belong to the class of muscular dystrophy, while the results of treatment are apparent in both general and local improvement.

FIG. 98.—Girl, aged sixteen years, with symptoms of the Erb type of juvenile dystrophy, associated with nasal and maxillary defects, who was greatly benefited by maxillary extension. (Described as Case I in text.)

Analysis of Two Cases.—CASE I (Fig. 98).—The patient was a girl, aged sixteen years. *History.*—Three operations had previously been performed for the removal of nasopharyngeal adenoids, with apparent recurrence after each operation. On account of general ill health, nervousness, and frequent colds, attended by evidences of both local and general arrest of development, the patient had for some time been unable to attend school continuously and suffered frequent illness.

Symptoms and General Appearance.—Height, 5 feet 2 inches, weight $92\frac{1}{2}$ pounds. More or less other indication of insufficient development. Marked inequality of development in the region of the shoulder-blades, closely approximating if not identical with the Erb type of juvenile dystrophy. This was so evident, her mother said, that the dressmakers had considerable difficulty in fitting her dresses. Marked nasal obstruction, arrested development of the lower part of the face, receding chin, and contracted upper and lower dental arches. Two superior bicuspids

had been removed (one on each side) by some dentist, with the mistaken idea of correcting dental irregularity. When she was about nine years old the spaces thus caused were almost completely closed by contraction of the upper dental arch. One lower bicuspid on the right side had been extracted about the same time with the same effect.

Treatment.—The upper maxillæ were readjusted by maxillary expansion and the lower arch made to correspond. Both arches were increased in an anteroposterior direction sufficiently to regain insofar as possible the space lost through extraction of the teeth, after which a dentist, Dr. P. B. Wright, of Milwaukee, inserted bridge-work to retain the full size of the jaws thus secured.

Result of Treatment.—As a result of this treatment, which was begun in October, 1906, there was improvement in facial symmetry and widening of the nares, which made better respiration possible. Coincident with this there was marked decrease of nervous symptoms, so much so that the patient was able to go on with her studies, and in due course graduated with honors from the high school. Growth in height and increase in weight began almost immediately. September 2, 1910, her weight was 107½ pounds and her height 5 feet 3 inches. Her mother reported that they no longer had difficulty in fitting her dresses, because the maldevelopment of her shoulders had disappeared.

Conclusions.—The author is aware that in consideration of the prognosis as generally understood with regard to the Erb type of muscular dystrophy, and in view of the later improvement of the muscular deformity, there may be question as to this being a true case of this affection. But without desire to claim too much, the fact that this young woman had for a time during the course of treatment a facial paralysis of short duration, and taking into account all the other symptoms, there is at least sufficient evidence to warrant the belief that her condition was one at least closely akin to muscular dystrophy, and that through the restoration of general health and improvement by renewal of constructive trophic changes continued degenerative progress was averted.

Case II (Figs. 99, 100 and 101).—*History.*—The patient in this case was a boy, aged ten years. He had been a mouth-breather for a long time, had scarlet fever, a sequela of which was evidenced by neuritis "extending around his head," and he had for a long time enlarged glands upon both sides of the neck. Bodily growth for a time seemed to be normal, but for some time had not been progressing as expected. He was unable to attend school continuously when treatment was begun.

Symptoms.—Both upper and lower arches were markedly contracted. Arrested development of the lower part of the face, particularly in the region of the lower jaw, caused marked recession of the chin. The nose was slightly to the right of the central facial line. There was an appearance of depression on the left side of the nose, including the malar region, with corresponding appearance of hyper-

trophic development of the same regions on the opposite side of the face. The thumb and palm of the left hand (Figs. 100 and 101) showed

FIG. 99.—Boy, aged ten years, described in the text as Case II. With unequal facial development, indicating tendency to hemiatrophy, tapir mouth, and other symptoms of the Landouzy-Déjerine type of muscular dystrophy. Dystrophy of the muscles of the shoulders and back, indicative of Erb's juvenile form of muscular dystrophy. Thumbs, palms, and hands and feet affected, as in progressive muscular dystrophy, but without fibrillary twitching. In this case tendency to normal growth was apparent immediately after separation of the maxillæ by expansion of his dental arches.

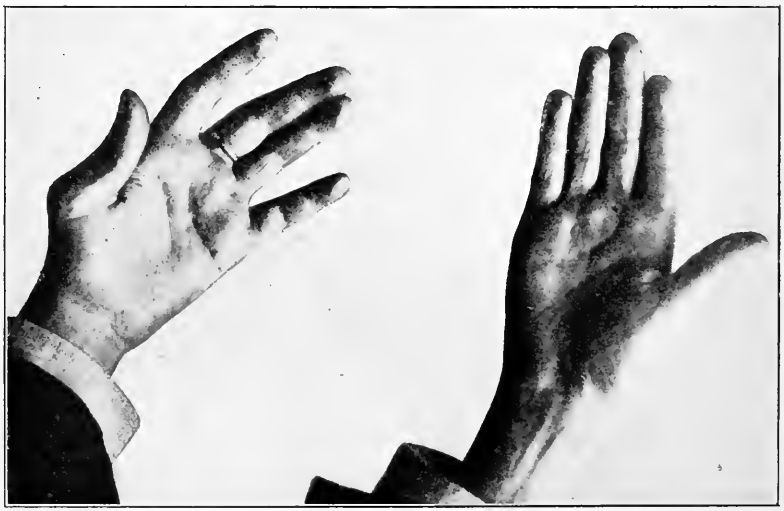


FIG. 100 FIG. 101

FIGS. 100 and 101.—The palms of both hands of the boy shown in Fig. 99. Waste of the thenar eminences. The altered position, form and size of the thumb may be noted in Fig. 100.

marked asymmetry of development. The thumb was believed to have been injured in infancy. The lips hung loose, the mouth was habitually open, with appearance much resembling the "tapir mouth" of the Landouzy-Déjerine type of muscular dystrophy.

Treatment.—The treatment consisted in expansion of both upper and lower dental arches with separation of the maxillæ, and in this way widening the nares.

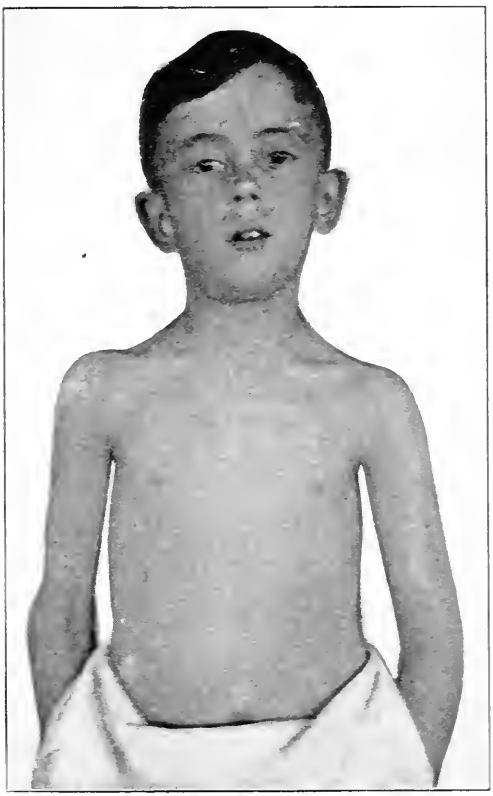


FIG. 102.—Boy, aged eight years, described in text as Case III. His face shows unequal facial development, nose insufficiently developed, maxillæ contracted; dental arches irregular; mouth-breather; one side of the mouth lower than the other, affection of the risorii muscles and characteristic appearance of chest and shoulders.

Result.—This treatment promptly improved his nasal breathing and has overcome to some extent at this date, eighteen months after treatment was begun, the relaxed condition of the lips, for the mouth no longer hangs open as it formerly did, and there is apparently going on a normal growth which is overcoming the asymmetrical appearance of the face, quite outside of alterations in facial appearance that might be expected from regulation of the dental arches alone. Nervousness has almost entirely disappeared, and general health is also much

improved. He has for some time been regularly pursuing his studies, and appears in all respects to be quite normal. (Later report.) In an eastern preparatory school this lad has led his class in both scholarship and athletics for two or more years.

Fig. 103.—Presents the back view of the same boy shown in Fig. 102. The typical difference in the shoulder-blades and the spinal curvature may be noted.

Case III.—The boy illustrated in Figs. 102 and 103 is another of the author's patients whose back, nose, and palate attest a tendency to muscular atrophy.

In this case also there was marked improvement in growth and general health as soon as the upper maxillæ were separated and nasal conditions thus improved.

Conclusions.—In these cases, as in the one previously described, the author presents the facts with suggestions of diagnosis rather than a desire to assume a dogmatic position. But with the great mass of other examples that might be cited to enhance the importance of the clinical evidences of these cases, the author unhesitatingly urges the great

possibilities of furthering constructive development in all respects and assisting to check progressive degenerative conditions, whether purely muscular or of nervous origin, by treatment such as described in these and other cases, as discussed more in detail on pages 550 and 556.

OTHER SPINAL DISEASES IN WHICH SYMPTOMS SOMETIMES EXTEND TO THE FACE, MOUTH AND JAWS.

Acute Progressive Paralysis; Landry's Paralysis.—This is an acute, rapidly progressing, ascending paralysis, usually fatal, but in rare instances recovery has been reported.

Etiology.—Its symptoms and frequent association with infectious diseases, in the absence of definite knowledge to the contrary, led to the belief that it is simply an evidence of acute infection. Autopsies have repeatedly demonstrated changes in the viscera, liver, kidneys, and lymph glands.

Pathology.—Changes in the spinal cord have been noted which include *acute myelitis, perivascular and inflammatory conditions, acute degenerative processes*, and sometimes pathogenic microörganisms, but no special germ. Also lesions of the nerves and in the neuron bodies, as well as in the pons and in the cerebral axis.

Symptoms.—Beginning with the lower extremities, the paralysis usually is accompanied by numbness, and rarely with pain without tremor, muscular contraction, or spasm, and progresses rapidly until the bulbar region is reached. The muscles of deglutition, speech, and of the face become totally paralyzed, as do the other portions of the body. There may or may not be sensory disturbance, but consciousness remains clear.

Prognosis.—Prognosis is grave. Death usually results in from a few days to two weeks.

Treatment.—Treatment is practically unavailing, but such as may be attempted must be directed to relief of the primary infection and the distressing symptoms, as well as to give prompt general support.

Locomotor Ataxia.—This is a chronic disease of the sensory portion of the nervous system.

Etiology.—Its most common cause is syphilis, although exposure to cold, overexertion, traumatism, excessive use of alcohol, and other factors are undoubtedly influential in this relation.

Pathology.—The posterior spinal ganglia and ganglia of the cranial nerves are first affected. The sympathetic ganglia are sometimes included. The axons of the neuron bodies of these ganglia undergo various forms of degeneration.

Symptoms.—The physical manifestations of this affection are numerous and varied. There is a first stage of pain or paresthesia, a second stage of ataxia or imperfect coördination of muscular action, and a third stage of paralysis. Among the rare symptoms we find bulbar paralysis resulting from continued progress of the disease, with the

usual facial, lingual, and other symptoms in this region, also blindness and other indications of affections of the cranial nerves. Hemiatrophy of the tongue sometimes occurs, or there may be muscular atrophy affecting facial, buccal, lingual, and palatal muscles or other muscles of the body.

Diagnosis.—While the general aspect of the disease requires differentiation from multiple neuritis, neurasthenia, diseases of the cerebellum, general paresis, and other similar affections, the somewhat rare cases having manifestations in the mouth and face would by reason of their history be readily distinguished.

Treatment.—Treatment is practically unavailable from a curative point of view. Such therapeutic measures as may assist in arresting progress of the disease are indicated as: Change of climate, regulation of diet, suitable exercise, massage, baths, counter-irritation, electricity, etc. When syphilis is known to be the cause, antisyphilitic treatment. (See Syphilis, page 107).

Friedreich's Ataxia.—A disease appearing in childhood, characterized by development of the spinal cord with affections of the neuroglia tissue which supplants the defective or degenerative fibers.[1] First described by Friedreich, in Heidelberg, in 1863 and 1876. Schultz, in 1877, showed that the disease is not related in any way to locomotor ataxia, but due to a defective development of the spinal cord.

Etiology.—Heredity seems to have an influence, since it occasionally happens that members of the same family are affected. Infectious diseases of childhood are at least predisposing factors. Alcoholism and syphilis in the parents are a parental heritage or active influence.

Pathology.—The spinal cord in these cases appears thin and small, with thinning of the pia mater. There is thinning of tissue in the posterior and lateral columns of the spinal cord, with extensive degeneration of the nerve fibers and changes in the gray matter of the cord.

Symptoms.—The affection may be congenital, or symptoms may develop gradually about the sixth or eighth year. In congenital cases the children learn to walk with difficulty, if at all, are unsteady upon their feet, fall easily, and have tendency to stagger. Feet are far apart, steps short and unsteady, with difficulty in preserving balance. The speech is slow, difficult, and indistinct.

In the author's practice a considerable number of hare-lip and cleft-palate infants have given evidence of arrested development of the spinal cord in association with the defective development which caused hare-lip and cleft-palate. In these case some of the children failed to learn to walk at all until three or four years old, and even the gait presented the characteristic uncertainty. There was the usual speech difficulty which always accompanies cleft-palate, but even after the palates were closed there remained the slowness of speech, difficulty in learning to use the tongue, and, above all, a disinclination to make

[1] Starr: Nervous Diseases, Organic and Functional, 4th ed., p. 388.

speech effort. In contradistinction to the usual description of such patients it was found that some of these children appeared to be unusually bright. Others had the stupid appearance of the weak-minded.

Diagnosis.—This is usually not difficult. The appearance of the characteristic symptoms before five or six years of age in most cases, or even later than sixteen years, is important.

Children are seldom ever affected by locomotor ataxia. Multiple neuritis is readily excluded by history of the case. Ataxia from cerebellar disease occurs later in life.

Prognosis.—In Friedreich's ataxia, as generally understood, the prognosis is unfavorable, and a gradually progressive increase of symptoms may be expected until the child is quite crippled from paralysis, and although the affection itself is not fatal, susceptibility to other disease often brings early death.

The author has observed a considerable number of defective infants and children with symptoms quite similar to those of Friedreich's ataxia, and he believes that other forms of affections of this character which signify less serious conditions should be recognized. Otherwise it does not necessarily follow that degenerative processes must steadily continue, for with correction of the external defects and proper general care many of these patients seem to show a tendency to outgrow the deficiency to some extent, and do learn to use the affected muscles in speech and movement with decided improvement.

Treatment.—No regular treatment can be depended upon. If the cases be of such character as those already described, patient upbuilding of general health and the steady cultivation of the affected muscles may do much, and is at least worth an effort.

Myelitis.—Hyperemia, anemia, and myelitis of the cord are affections that relate to conditions of the blood and to infection which by reason of this fact are necessarily more or less closely associated with diseases of the mouth.

Symptoms.—The degenerative conditions of the cord in acute and chronic myelitis cover a wide range. They include paralysis of the parts of the body supplied by the spinal nerves, trophic changes, and finally affections of speech, facial paralysis, and other indications that the disease has extended to the bulbar region.

Prognosis.—The prognosis is unfavorable. Usually such patients become chronic invalids.

Treatment.—Treatment is to support the general health, give the patient such comfort as may be possible, and to guard against complicating disease which may hasten death. Other measures which are recommended for spinal diseases are to some extent applicable in these cases.

Pachymeningitis Cervicalis Hypertrophica.—This is a disease of rapid progress, presenting the symptoms of myelitis of the cervical region.

Pathology.—Compression of the cord results from fibrous thickening of the dura mater, which also affects the nerve roots in their passages through the dura.

Symptoms.—This affection is of particular importance to our subject because its early symptoms may easily be mistaken for evidences of other diseases. In the first stage there is pain in the back of the neck and head, with stiffness of the neck, but the fact that pain is also felt in the hands and arms serves to distinguish this from other causes of pain in the back of the head and neck. In the second stage there are muscular contractions, and in the third stage paralysis.

Prognosis.—The prognosis is fairly good if the disease be diagnosticated in its early stage. The responsibility of the oral surgeon for prompt reference of such cases for immediate proper treatment is therefore important.

Treatment.—Treatment consists of mercury and iodide of potash in large doses, since the cause of the affection is presumed to be syphilis. The actual cautery is also applied to the back of the neck, and remedies are given for the relief of pain.

Spinal Meningitis.—Etiology.—This is an acute meningitis, limited to the spinal cord, which develops after various forms of disease of the spinal column or dura mater. It follows spinal injuries and other diseases of the spinal cord, but its most frequent causes are infectious diseases ranging from comparatively simple infections through pneumonia, typhoid, septicemia, etc. Its forms are acute or chronic.

Symptoms.—*Acute meningitis* develops suddenly with fever, chill, malaise, nausea, and other symptoms of acute infection. Pains in the head, back, and limbs are followed by stiffness of the back and neck and rigidity of the body. Hyperesthesia of the skin surface, muscular spasms, and twitchings are followed by anesthesia and paralysis as the degeneration progresses. Vasomotor disturbances, trophic changes, etc.

Chronic cases quite closely resemble the acute except that the onset is less marked and symptoms due to changes occurring through longer continuance of a somewhat wider range.

Diagnosis.—Diagnosis is best accomplished by lumbar puncture. Usually the spinal fluid contains leukocytes and bacteria of various kinds which are representative of the character of infection.

Prognosis.—The prognosis depends largely upon the character and influence of its septic cause.

Treatment.—Treatment consists in rest in bed, relief of the symptoms, applications of heat, plasters, or actual cautery along the spine. Sedative and general treatment should be appropriate to the infection.

Its chief interest to our subject lies in the possibility of the influence of mouth infection and recognition of its symptoms in differential diagnosis.

DISEASES OF THE BRAIN.

Cerebral Diseases.—Cerebral Hemorrhage, Cerebral Embolism, and Cerebral Thrombosis.—These are chiefly important to the oral surgeon from a symptomatological point of view, because among the symptoms headache is one of the most common premonitory evidences of these affections, particularly with endarteritis. Plethoric individuals with much redness of the face and distention of the veins may be the subjects; in other cases they are pale, ill-nourished persons, the sufferers of existing diseases, weak hearts, and similar conditions. Headache of this character commonly affects the frontal or occipital regions. It is usually bilateral and varying in intensity, and must needs be distinguished from headache due to other causes. When hemorrhage, embolism, or thrombosis is followed by paralysis, the tongue, face, and palate are included in the hemiplegia, the muscles about the eye that close the lids being the only ones which are not involved, thus distinguishing this form of facial paralysis from that due to affections of the facial nucleus in the pons or of the facial nerve.

Intracranial Pressure.[1]**—Symptoms.**—When the contents of the skull are slowly increased by a small tumor or by a small clot, the displacement of cerebrospinal fluid and the narrowing of the veins prevent tangible effects. But when a large clot suddenly forms, the pressure causes venous stasis and a slowing of capillary circulation. Nature in attempting correction raises the arterial tension, and thus maintains the nutrition of the medullary centers necessary to life. If the pressure is increased beyond the power of adjustment of the heart, then a weak, rapid heart action, a relaxed arterial tension, and an irregular respiration are followed by collapse and death.[2] Arterial tension therefore indicates the degree of intracranial pressure. A tension of 220 mm. developed suddenly is dangerous and a tension of 280 is fatal.

Treatment.—Decompression is the only means of relieving intracranial pressure when the arterial tension rises to the danger point.[3]

Hemiplegia.—Hemiplegia may be defined as paralysis of motion of one side of the body, usually due to cerebral diseases and occasionally due to injury or disease of the spinal cord.

Cerebral Spastic Paralysis.—Etiology.—This disorder results from maldevelopment. Atrophy or injury to the brain from any cause may give rise to symptoms of hemiplegia.

Symptoms.—Cerebral spastic paralysis may develop in infancy and be attended by high fever (temperature 102° to 105° F.), nausea, vomiting, headache, and delirium; in the case of older persons it may be associated with feeble-mindedness, imbecility, idiocy, blindness, deaf-mutism, and epilepsy. The paralysis may affect the face and

[1] Starr: Nervous Diseases, Organic and Functional, 4th ed., p. 466.
[2] Kocher Hirndruck, Nothnagel's spec. Path. und Ther., ix, 32.
[3] Cushing: Am. Jour. Med. Sc., September, 1902, and June, 1903.

jaws in common with other anatomical regions, or there may be spastic rigidity or athetosis (inability to retain the fingers in any spastic position in which they are placed, the constant state of slow movement of fingers and toes, flexion, extension, etc.).

In these cases the athetoid movements may affect the face and tongue, causing constant grimaces and interfering with speech, or there may be choreic movements more violent than athetosis. Starr[1] describes a case with total paralysis of the tongue and right hemiplegia. This child at the age of twelve years was still unable to articulate, and food was pushed into the throat by the finger and then swallowed.

Treatment.—An attempted description of the treatment of these cases would be quite outside the purpose of this volume. This reference is included because the symptoms which affect the face and jaws sometimes require to be differentiated from other pathological states causing similar paralysis. Moreover, a field is developing which promises useful results in the differential diagnosis of mental defects. This applies particularly to the distinction between aphasia (partial or complete loss of the use of language by the tongue or pen), a common associate of right hemiplegia, and the inability to pronounce certain words and other evidences of defective brain-cell development due primarily to arrested development of the jaws or disproportion between the size of the tongue and its maxillary and palatal enclosures. In the latter case the large size of the tongue, in comparison with the jaws in embryo, makes its proper use in word-forming exceedingly difficult, or impossible if later growth of the jaws be arrested. Children, therefore, with large tongues and narrow or otherwise deformed palatal vaults can only learn to speak certain words with great difficulty if at all. Undoubtedly this disadvantage causes disinclination to make the attempt, thus the necessary brain centers are not properly stimulated to activity. As a result an individual in the course of time becomes really defective, although in the beginning imperfect form of the parts and organs concerned in speech, which could have been readily corrected if properly diagnosticated, was chiefly responsible for the ill-developed brain which later became evident. It must, of course, be understood that these stigmata of degeneracy, as Talbot[2] has so lucidly explained, quite commonly go hand in hand. The mouths of idiots, epileptics, and other children are characteristically contracted and ill-formed because the irregular cell development affects these and other parts as well as the brain. Nevertheless it is a matter of utmost importance that no factor be allowed to interfere with brain growth, and every impediment to proper mental training be removed. To this end recognition and distinction between affections which might by any possibility act as predisposing or exciting causes should be emphasized. Proper expansion of the dental arches, which widens also the almost

[1] Nervous Diseases, Organic and Functional, 4th ed., p. 524.
[2] Stigmata of Degeneracy, Etiology of Osseous Deformities.

invariably associated contracted nares, and the surgical correction, if necessary, of any defectively formed parts, should receive due consideration and become a matter of routine procedure.

Encephalitis; Cephalitis.—By this term is meant inflammation of the brain in contradistinction to that of the membrane of the brain.

Etiology.—The general opinion seems to be that it is an acute infectious disease. There is some question as to whether or not it could be caused by an injury to the head without fracture or meningitis, as it is usually only after the invasion of bacteria that bruises in the soft tissues of the brain are followed by inflammation. The pathological conditions with which it is etiologically associated are scarlet fever, influenza, pneumonia, erysipelas, whooping-cough, mumps, diphtheria, ulcerative endocarditis, otitis media, and septicemia. Ptomain poisoning, alcoholism, syphilis and similar causes also bear an important relation. Infection from diseased conditions of the mouth, whether carried directly through circulatory or lymphatic channels or by extension of disease through associated sinuses, is a matter of important consideration, particularly as this disease occurs most often in children and young people, and, as is well known, the mouths of most children, except under unusually rare conditions, almost always contain diseased teeth or gums, or both, to predispose to such infection.

Pathology.—The changes in brain structure may be of the character of an acute hyperemia, with extension of the bloodvessels, rupture of the walls, and other characteristic effects, or they may be attended by degeneration of the neurons with entire destruction of the cell and nerve elements.

Symptoms.—*General.*—The general symptoms are malaise, vertigo, headache, sudden chill, followed by temperature that may be as high as 104° F., or somewhat less, with vomiting, convulsions, and, as the disease progresses, stupor or coma. The pulse is rapid but regular, and the respiration usually normal. If death does not follow coma and there is gradual recovery, there may be delirium or actual maniacal excitement.

Local.—Since lesions of this character may affect different parts of the brain, the symptoms are in accordance with the affected area, and if the facial and lingual muscles be paralyzed, as in acute bulbar palsy, there will necessarily be defective speech, difficulty in swallowing, and change in facial expression, just as there might be imbecility from involvement of the frontal lobe, strabismus, or paralysis of ocular movement, if the oculomotor nuclei were affected and decrease of coördination from involvement of the cerebellum or characteristic symptoms from the spinal cord.

Prognosis.—The prognosis is bad. The severity of the convulsions, depth of the coma, degree of temperature, pulse, respiration, and physical condition of the individual are determining factors in deciding between a fatal result or gradual recovery.

Treatment.—Treatment includes complete removal and disinfection or correction of any known cause whenever such treatment may be possible. Obviously there should be careful consideration of even remote sources of local irritation. General care should be in the nature of purgatives, ice applied to the head, antipyretics, hot mustard baths or hot foot baths, and similar expedients to stimulate flow of the blood to the extremities.

Cerebral Meningitis.—Etiological Classification.—The several forms of this affection are as follows:

Primary Meningitis.—(1) *Epidemic cerebrospinal meningitis* (spotted fever), due to the Diplococcus intracellularis. (2) *Endemic meningitis of infants*, due to infection by various microörganisms. (3) *Septic meningitis* occurs with wounds, fractures, and operations, and sometimes follows otitis media, and is due to streptococcic or staphylococcic infection.

Secondary Meningitis.—This may result from pneumonia, ulcerative endocarditis, empyema, typhoid and typhus fever, influenza, the eruptive fevers of childhood, erysipelas, and other forms of disease due to microörganisms. The most important forms are: (4) *Tubercular meningitis.* (5) *Syphilitic meningitis.*

Meningitis in infants is of particular interest to those whose practice is limited to the operative field under consideration, and who do not practise general medicine, since it may be due to septic infection following disease of the mouth, nose, and ear, all of which are closely associated or may be secondary to operations in the region of the mouth, throat, and sinuses, because of the conditions which are favorable to more direct infection from these regions. The syphilitic forms bear a considerable measure of diagnostic importance which relates to all fields of practice.

Pathology.—Cerebral meningitis is marked by hyperemia and congestion of the pia followed by exudation of serum, lymph, fibrin, and pus. As the disease extends, the cortex, ventricles, and cranial nerves become affected, as does the cerebrospinal fluid, examination of which by lumbar puncture makes diagnosis possible. In the tubercular and syphilitic forms, characteristic evidences may be noted.

Symptoms.—The cranial symptoms of all forms of meningitis may be summarized as follows: Initial chill followed by high temperature, usually about 104° to 106° F., rapid pulse, headache, delirium, stupor, insomnia, rigidity and pain of the back and neck, hypersensitiveness to sound, strabismus, and disturbance of vision. Sometimes deafness is a noticeable symptom and facial paralysis very commonly occurs, as may also general convulsions. Marked restlessness, screaming, and other evidences of irritability are sometimes accompanied by champing movements of the lower jaws, lips, and tongue. Bulging of the fontanelle or hydrocephalus may be apparent in the long-continued cases (Figs. 104 to 107).

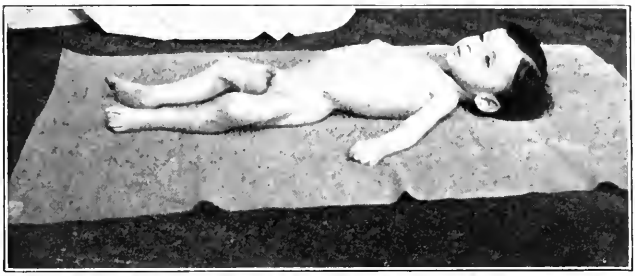


FIG. 104.—Patient with septic meningitis, subsequently fatal; relaxed; comatose. ("Brudzinski's sign," after Northrup.)

FIG. 105.—Method of eliciting the identical reflex, or neck sign, by flexing head on chest. ("Brudzinski's sign," after Northrup.)

FIG. 106.—Method of eliciting the identical reflex, or neck sign, by reflexing head, on chest. ("Brudzinski's sign," after Northrup.)

FIG. 107.—Producing contralateral reflex, or leg sign, by passive flexion of one leg, causing a reflex flexion of the other leg. ("Brudzinski's sign," after Northrup.)

Treatment.—In the cerebrospinal form the antiserum of Flexner, to be obtained at the Rockefeller Institute in New York, seems to offer the only hopeful means of combating the disease. By lumbar puncture 15 to 30 c.c. of cerebrospinal fluid is withdrawn and the same amount of antiserum is injected directly into the spinal canal slowly and carefully, in order to avoid the production of symptoms of increased pressure. This is repeated at intervals of three or four days. The septic forms require the correction of the sources of infection wherever possible, and with infants the greatest possible care should be taken to diagnosticate definitely the pathological condition which has acted as a predisposing or exciting cause. Tuberculosis and syphilis require treatment for those affections. General treatment for relief of the symptoms and to assist nature in combating the ill effects of the disease is in the nature of stimulating and supporting measures to conserve and build up strength with nourishing food and the judicious use of stimulants. Ice-packs to the head and spine, and cool sponge baths, supplemented by the use of sedatives, such as the bromides, codein, or morphin, if necessary in small, frequently repeated doses, may be employed.

Multiple Sclerosis.—This disease affects both brain and spinal cord in varying degree, and is characterized by small plaques or eyelets of sclerotic tissue scattered irregularly through the central nerve system.

Etiology.—It sometimes affects infants, but is more common between the tenth and thirtieth years, very rarely affecting older persons. It is generally recognized as due to infection from any of the various diseases caused by microörganisms.

Pathology.—The sclerotic patches vary from a millimeter to several centimeters in diameter. There may be hundreds of these plaques in the white matter and other portions of the brain and spinal cord. There is production of a neuroglia structure and disappearance of the myelin sheath of nerve fibers.

Symptoms.—Its symptoms are those that might be expected from lesions which involve the brain axis and spinal cord. In addition to the disturbance or loss of muscular action of various portions of the body, there is marked defect in speech, characterized by slow, jerky utterance of words, pauses between words or syllables, and forced effort to pronounce. There may also be tremor of the face and tongue, with jerky movements of the head. In one type the bulbar symptoms appear first.

Prognosis.—It is claimed that some patients gradually recover, others die within two years, while others still live for many years.

Treatment.—Stimulating and supporting treatment, and that which relieves the symptoms, is about all that can be done except the application of electricity, which is of questionable usefulness. Its importance to our subject lies in its recognition in diagnosis.

Abscess of the Brain.—**Etiology.**—Injury of the head with or without fracture and particularly septic injection from compound fractures, foreign bodies forced through the skull, or other infection of any kind that may reach the brain structures, are among the causes. Abscesses and necrosis of the jaws, septic disease of the sinuses and middle ear, which are so frequently associated in disease, by reason of their direct avenues for conveying specific and other infections, have an important diagnostic as well as etiological relation.

Pathology.—Infection by any of the pathogenic microörganisms may lead to a purulent encephalitis with small localized softened conditions of the brain tissue or larger collections of pus as with other abscesses.

Symptoms.—The general symptoms of cerebral abscesses are, in the order of their importance: (1) Headache, general but sometimes located over the seat of the abscess. (2) A change in mental characteristics of the nature of irritability, alternating with dulness, imperfect attention, slowness of thought, and defects of memory, a semicomatose condition and appearance of illness out of proportion to the other symptoms. (3) Abnormal temperature. (4) Changes in the blood. (5) Tenderness of the head to percussion with change in the percussion note over the site of the abscess. (6) Facial palsy of the peripheral type upon the side affected. (7) Optic neuritis. (8) General febrile symptoms with occasional chills.

The development of these symptoms in a patient who has had an injury of the head, or is the subject of chronic otitis media, or who has been exposed to any of the causes already mentioned, should awaken grave anxiety.[1]

Diagnosis.—The diagnosis depends upon the history of the injury or discovery of the possible source of infection and differentiation from meningitis, thrombosis of the lateral sinuses, and acute encephalitis.

Prognosis.—The prognosis necessarily depends upon the possibility of successfully draining the abscess.

Treatment.—Surgical opening of the abscess cavity and evacuation of the pus.

Thrombosis of the Venous Sinuses.—Thrombi usually form in the lateral or transverse sinuses, but may occur in any of the cranial venous sinuses.

Etiology.—This disease is caused by phlebitis of the wall of the sinus due to inflammatory extension. The source is usually some septic process from the dura mater or from otitis media, or chronic nasal, orbital, or oral diseases. It may result secondarily from carbuncles and abscesses of other portions of the body.

Pathology.—The thrombosis is usually a soft clot or clots adhering to the wall of the sinus. These may become hard or organized, or are purulent with any of the evidences of pus formation.

[1] Starr: Nervous Diseases, Organic and Functional, 4th ed., p. 553.

Symptoms.—The general constitutional symptoms are quite similar to those of brain abscesses. There is choked disk in over one-half the cases within the first week, especially with thrombus of the lateral sinus, which is the most frequent through its close connection with the ear. Edema and swelling with venous congestion of the face and about the eye, with other eye symptoms, occur in thrombus of the cavernous sinus from nasal and orbital disease.

Prognosis.—Absolutely fatal, except when thrombosis of the lateral sinus enables operation to be performed.

Treatment.—Surgical opening of the sinus, cleansing of the clot, and curettement.

Tumors of the Brain.—Brain tumors in common with other brain affections bear a certain symptomatological relation to our subject, chiefly useful in preventing errors of diagnosis which by causing delay might lead to serious results. Early differentiation is therefore of the first importance.

Pathology.—Nearly all varieties of tumors have been found within the brain, some frequently, others more rarely. Tubercular tumors are by far the most common. (See Tumors, page 431.)

Symptoms.—The general symptoms due to the existence of a new growth in the brain irrespective of its position are headache, general convulsions, choked disk, and optic atrophy, changes of disposition and mental power, vomiting, vertigo, insomnia, changes in the pulse rate, attacks of syncope, polyuria, and progressive malnutrition.

Focal symptoms of the disease in the cortex of the brain or beneath the cortex in the projection tracts which join the cortex to the various subcortical centers, are unilateral spasms, monoplegia or hemiplegia, paresthesia or anesthesia in one or more limbs, hemianopsia, and the various forms of aphasia. Affections of the cranial nerves and basal parts of the brain occur with tumors in the basal ganglia and cerebral axis, or external to the brain upon the base. Symptoms affecting the twelve cranial nerves necessarily cover a wide range.

Diagnosis.—The presence of any of the foregoing symptoms, unless otherwise accounted for, with reasonable certainty, should at once demand consultation or reference to a neurologist or surgeon of sufficient experience in brain surgery to prevent the likelihood of delay, which might prove serious.

Complete Report of Case of Brain Tumor.—The following complete report of a case of brain tumor received through the courtesy of Dr. Charles H. Frazier is included as a valuable illustration of symptoms such as might be noted in treatment of pathological conditions of the mouth, jaws, and surrounding parts which would require distinction from similar indications of local diseases. Their prompt recognition and early reference of the patient to a brain surgeon would certainly tend to increase the likelihood of avoiding a fatal result:

Amos Kump (25). University Hospital. No. 2223
Littletown, Pennsylvania.

Service of Dr. Frazier. Referred by Dr. Harry S. Crouse.
Admitted March 3, 1907. Discharged April 12, 1907 (death).
Diagnosis. *Brain tumor.* Not found.
Operation. Bilateral decompression, April 11, 1907.
Result. Death.

Chief Complaint.
Blindness, intense headache, vomiting.

Social History.
Patient is a bricklayer and stonemason. He is unmarried. He uses beer and whisky sometimes to excess. He chews tobacco rather freely. He had specific urethritis about a year ago, but has no history of specific infection.

Family History.
Father and mother both living. Father has had St. Vitus' dance for over forty years. He is about seventy years of age. Two brothers and three sisters living and well. One sister died of eclampsia. The patient says the members of his family are all more or less "nervous." No family history is obtained of tuberculosis, or malignant, cardiac, or renal disturbances.

Previous Medical History.
Negative, except that he has had a number of attacks of tonsillitis.

History of the Present Condition.
The patient is in an advanced stage of mental hebetude, probably as a result of bromism, and his statements are vague and unsatisfactory. He says that last winter he began to have weakness and soreness about the articulation of his jaw. The soreness afterward spreading to his head, where it has persisted ever since. About two months ago blindness developed in right eye, and this was followed about two weeks later by blindness in the left eye. During this same period he has vomited a number of times. He is not able to walk about unless someone leads him. He believes his inability to walk is caused by his blindness. His general health he believes has not suffered much. Headache of late has been very severe.

Physical Examination.
A rather poorly developed and emaciated male subject, looking considerably older than his given age of twenty-five years. Skin is covered with a profuse deeply colored red eruption, probably the result of bromides. No noteworthy glandular enlargements. Pulse is regular, volume fair. Chest poorly developed. Expansion fair and equal on both sides. Heart and lungs negative. Abdomen soft and symmetrical. Abdominal organs negative.

Examination by Dr. Spiller, March 6, 1907.
The left pupil is much larger than the right. Both are immobile to light; slight contraction is obtained in each pupil in attempt at convergence. He says he sees light with each eye separately. He wrinkles the forehead well, closes the eyelids, shows teeth, and draws up each corner of mouth well; therefore he has no involvement of either facial nerve. Tactile sensation is completely lost in the entire distribution of the right fifth nerve. Provided no pressure is produced. Sensation of pain is lost in same distribution. Sensation is preserved along the border of the lower jaw in the distribution of the cervical nerves. Conjunctiva and corner of right eye are anesthetic, not so of the left eye. A piece of paper put far up the right nostril is not felt unless pressure is produced and causes no lacrimal reflex. The jaw is swollen and uvula is absent. Sensation of left nostril is normal. He is distinctly deaf to voice in both ears. The soft palate moves very imperfectly on the right side. The sense of smell is greatly impaired on each side. The tongue is protruded straight. Grasp of each hand is fair. Upper limbs move freely in all parts, biceps and triceps tendon reflexes not distinct on either side. Sensation of touch and pain are normal in each upper limb. Movements of lower limbs are free in all parts. Patellar tendon reflexes and Achilles tendon reflexes are lost on each side. Brudzinski reflex is not obtained; toes are not moved distinctly in either direction. Sensation of touch and pain are normal in each limb. Gait and station are very ataxic; he has

marked sway with his feet close together. His body is covered with eruption, probably from bromides. Taste for salt and sugar probably lost on front and anterior part of tongue.

Eye Examination by Dr. de Schweinitz.

Palpebral fissures are about equal width, left eye slightly divergent. Left external rectus movement is preserved. Movement of internus superior and inferior rectus is markedly limited.

Right Eye.

There is loss of movement of external rectus and marked limitations of movements of superior and inferior recti, with almost lost internal rectus movement. There is extensive double optic neuritis with large retinal hemorrhages on the right side.

April 11, 1907. Last night the patient became unconscious; for the last few days he has not seemed to be quite well. He was transferred to Dr. Frazier's service for operation. A lumbar puncture was made, and the cerebrospinal pressure was found to be equal to 27 mm. of mercury (351 mm. of water) and about 5 mm. of mercury (65 mm. of water).

April 12, 1907. A decompressive operation was done on each side of the head just above the ear, in order to relieve intracranial pressure. The brain bulged much on the right side. The patient died April 12, about 2 P.M.

April 13, 1907. *Autopsy* today disclosed large tumor of the left lingual lobe, densely adherent throughout the entire right middle fossa of the skull, and extending over the petrous portion of the temporal into the posterior fossa. The growth appeared to extend across the inferior surface of the pons and medulla, involving many of the cranial nerves. The brain tissue of the temporal lobe was very much softer than usual, and could not be removed from the skull without being badly broken up.

Description of Operation by Dr. Frazier.

Bilateral decompressive operation. Horseshoe cutaneous flap, long incision in temporal muscle and fascia. Crucial incision in dura—not nearly as much tension on right as on left side. There was great bulging on left side (which proved to be the site of tumor).

Diseases of the Pituitary Body.—Diseases affecting this body, particularly tumor formations, have been so frequently observed in acromegaly and the pituitary extract administered internally has in some cases appeared to have such a marked effect in checking the progress of this affection that lesions of the hypophysis are now regarded as definitely affecting development. Notwithstanding this, Coplin reports twenty-five tumors of the hypophysis as being on record without acromegaly. Tuberculosis and the gummata of syphilis and adenomata are its most common affections. Other tumors have been reported, but are somewhat rare.

Treatment.—As already stated, the administration of pituitary extract is sometimes beneficial in arresting abnormal growth. Removal of the gland is required in cases of tumor growth.

DISEASES OF THE CEREBRAL AXIS.

Bulbar Palsy.—This form of progressive paralysis affects the lips, tongue, and larynx.

Etiology.—The claims of authors who have brought forward certain specific causes have not been fully accepted. It is safe to assume, however, that it may result from any factors contributing to nerve-cell degeneration which may affect the motor cells of the medulla oblongata and pons varolii, such as the various intoxications, syphilis, etc.

Pathology.—There is a gradual atrophy and degeneration of the motor nuclei and nerves of the medulla oblongata and pons, which may or may not be accompanied by degeneration of the pyramidal tracts. There is usually marked degeneration of the nerves involved which are the hypoglossal, facial, pneumogastric, glossopharyngeal, vago-accessorial, and motor trigeminal.

Symptoms.—When the disease affects the bulb either primarily or as an extension from the cervical region of the spinal cord the clinical picture is often described as "syringobulbia." Atrophy of the tongue and unilateral or bilateral paralysis of one or both vocal cords are among common symptoms.

FIG. 108.—Patient suffering from bulbar paralysis. Double ptosis, slight external strabismus, facial paralysis, with lack of facial expression and inability to close the lips are to be seen. The effort to open the eyes causes a wrinkling of the forehead. (After Starr.)

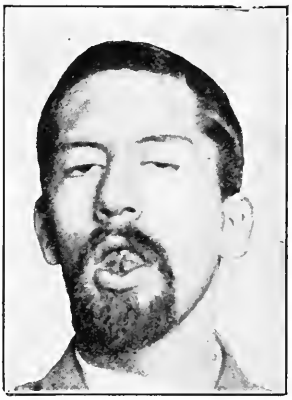


FIG. 109.—Bulbar paralysis. Double ptosis, with external strabismus, flattening of the face, inability to close the mouth, and atrophy of the right half of the tongue are to be seen. (Icon. de la Salpêtrière.) (After Starr.)

Defective speech is first noticeable in an effort to pronounce such letters as *d*, *g*, *k*, *l*, *r*, *s*, *t*. Its tendency is to progress until speech is completely lost. The constant flow of saliva from the mouth is exceedingly annoying. Difficulty in swallowing is made doubly by fluid passing into the nose or larynx. The lips cannot be contracted, the voice also is affected by paralysis of the soft palate and larynx, as is evidenced by loss in volume and change in tone. Mastication is difficult, due to the loss of the use of the tongue. There may or may not be stiffness or weakness of the muscles of mastication. Usually marked atrophy of the lips and tongue is noticeable, so much so, that it is impossible to protrude the tongue beyond the lips and its tremor is markedly noticeable.

Diagnosis.—Its distinguishing feature is the fact that in addition to the symptoms previously described, the upper part of the face and the branches of the facial nerves which supply the upper part of the face are apparently normal, and the affected portion is limited to muscles of the mouth and chin, the upper part of the face being quite free. It is sometimes necessary to distinguish it from pseudo-bulbar palsy, in which there is absence of atrophy and vibratory tremors. Other brain and nervous affections causing paralysis are more easily excluded (Figs. 108 and 109).

Prognosis.—The termination is necessarily fatal and may come in the course of a number of days or years, according to the rapidity of the action of destructive process.

Treatment.—Treatment is at best only palliative, since nothing can cure the disease, and it is doubtful if efforts to check its progress are effective. To the oral surgeon its interest in this regard comes by reason of the fact that he will usually be called in such cases in the hope that he may be able to relieve the exceedingly distressing salivary symptoms, and while the administration of tonics and spraying the mouth with astringent remedies may give a measure of temporary comfort, they cannot be permanently effective.

DISEASES OF THE CRANIAL NERVES.

In considering affections of the nerves no attempt will be made to include all of the pathological conditions which affect each of the twelve cranial nerves. Since, however, the primary centers of cranial nerve nuclei are so closely joined by associated fibers, and combined action is such a necessary part of reflex action concerned in all such an infinite number of movements and sensations intimately connected therewith, and because involvement of the higher centers makes up the complement of coördination as affecting the basal ganglia through which provision is made for automatic acts, it is evident that there must necessarily be more or less wide distribution in symptoms resulting from cranial nerve disease, even though the actual pathological changes may be evidenced in only one nerve or in a distinct region of nerve distribution. It therefore becomes necessary for us to consider each nerve through which pathological states may be evidenced that may affect nerve distribution in the region of the mouth, face, and jaws, or in which connection therewith may be more indirectly evidenced. Beyond this, however, an attempted detailed distribution of more remote affections would not only be inadvisable, but impracticable in this relation.

LESIONS OF THE FIRST OR OLFACTORY NERVE.

The first or olfactory nerve governs the sense of smell through the specially endowed primary neurons and finer filaments distributed

through the Schneiderian membrane of the nose. It is particularly sensitive to any disease which may be inflammatory or to other destructive processes affecting the mucous membrane of the nose and the nerve filaments it contains.

Anosmia (Loss of smell; perversion of smell).—**Etiology.**—Loss or perversion of smell, which is the direct result of such disease, may be brought about by nasal catarrh, arrest of nasal secretion when due to disease of the fifth nerve, tumors of the nose or polypi, ethmoiditis or disease of the bones and cells in this region, as well as meningitis, brain tumors, if located in the anterior fossa, and any disease which may destroy or disarrange the functional activity of the olfactory bulb or tract. Occasionally the activity of this center is an evidence of hysteria.

Diagnosis.—Since catarrhal affections of the nose are so closely associated with disease and deformities of the mouth and allied affections, as are also pathological conditions of the maxillary sinus, through which the sphenoidal, frontal, and ethmoidal sinuses are so constantly involved by extension of the disease from one to the other, it is self-evident that due consideration must be given disorders of the oral cavity in considering both the etiology and treatment of these cases. The loss of sense of smell is sometimes a valuable test, inasmuch as it is seldom an evidence of unilateral disease.

Treatment.—The treatment concerns the oral surgeon only insofar as the correction of the oral disease may be involved, and for differentiation in the defect of such etiological influences as may require treatment at the hands of rhinologists, neurologists, or those who follow other divisions of practice.

LESIONS OF THE SECOND (OPTIC) NERVE.

Hyperemia and Anemia.—Hyperemia and anemia of the optic nerve are associated with similar conditions of the brain. Thrombosis of the retinal artery may be caused by arterial disease or malarial and other poisons. Blindness may result from either. Each is usually associated with headache. Both are therefore matters of consideration in differential diagnosis when pain in the distribution of the fifth nerve is a marked symptom.

Edema of the Optic Nerve, "Choked Disk," "Papilledema."—Etiology.—Edema occurs from obstruction of the circulation in the eye or increased intracranial pressure, and is a common symptom of tumors, and occasionally of abscesses of the brain. It may cause impaired vision or blindness, is usually bilateral, but may for a time affect one eye. Its diagnostic value in cases of brain tumor, brain abscess, and intracranial pressure of any kind is of the first importance, and being associated so often with trigeminal pain should always be sought for by proper examination wherever there is suspicion of the existence of such disease.

Optic Neuritis.—Etiology.—Optic neuritis may be the expression of known heredity or result from any of the blood poisons which are recognized as of etiological importance in other forms of neuritis such as alcoholism, leukocythemia, diabetes, and syphilis, or even rheumatism and gout. Direct infection from brain disease, pressure of brain tumors upon the nerve and other evidences of intracranial disease may be direct causes.

Symptoms.—Among the more prominent symptoms are failure of sight, objects become blurred, sensitiveness to light, decrease and disarrangement of the vision field. The additional symptoms of headache, vertigo, digestive disturbances, nausea, vomiting, loss of strength, which are common to so many different affections, confuse the question of diagnosis and not infrequently require differentiation.

Optic Nerve Atrophy.—Etiology.—Atrophy may result from any of the diseases or indirectly from all of the causes recognized as affecting brain and nerve lesions.

Symptoms.—The symptoms of gradually increasing blindness and loss of the field of vision may be associated with pain in the eyes and discomfort after their use or exposure to light.

Diagnosis.—All the diseases directly affecting the optic nerve and all other affections of the eye, whether due to visual defects, muscular weakness, overuse, or any other cause in which the symptom of pain is a marked feature, and conjunctival affections which by any possibility could be confused with or induced by buccal diseases, should be referred to a competent oculist. All attempts at description of symptoms which could by any possibility lead operators in other fields to attempt eye examination for the purpose of differentiation between the various pathological optic states have been excluded because the author is very firmly of the belief that such attempts in practice are in the highest degree pernicious. That there is a rapidly developing field for useful consultation and coöperation between the dentist, the oral surgeon, rhinologist, and the ophthalmolgist is undoubtedly true. In the author's practice the valuable assistance of competent examination has many times led to the avoidance of great error in diagnosis and treatment. On the other hand, gratifying results have sometimes been brought about by the correction of causes of reflex disturbances from dental irritation which were evidenced by pain in the eye or eyes or other optic disturbances which might otherwise have been confused with the result of eye-strain.

Treatment.—In the correction of chronic conjunctivitis due to nasal disease proper maxillary expansion frequently may be depended upon to open avenues for proper exit of secretions and by improvement in their character effectually to restrain certain forms of this affection. It is confidently believed that better understanding of the interrelation in development between the bones of the head and face as influenced by development of the jaws, may in the future, by earlier widening of the palate for correction of contracted maxillæ, lead to more symmet-

rical development of the orbits in common with other parts, and in this way reduce to some extent the frequency of myopia and presbyopia. In one case referred by the patient's oculist, believed to be marked strabismus due to unusual nervous and weak muscular inequality, markedly increased by general causes, spreading of the maxillæ and oral treatment appear to be giving valuable assistance at the present time in the direction of aiding a girl, aged ten years, to overcome this defect without other operative assistance.

Such treatment is at least helpful and beneficial in a general way, even though not entirely curative.

LESIONS OF THE THIRD, FOURTH AND SIXTH NERVES.

Paralysis or other disorders affecting the movement of the muscles of the eye and eyelid bear a considerable measure of diagnostic importance in the distinguishment of nervous disorders affecting the mouth or other portions of the face and jaws, for the reason that factors which are responsible for the causation of diseases of oral nerves are identical with those which lead to other brain and nerve affections. Because the sympathetic fibers of the third nerve, which leave the spinal cord in the first dorsal nerve root, pass to the superior cervical ganglion and from the cavernous plexus to the Gasserian ganglion of the fifth nerve, and with the first branch of the fifth to the iris; there is also much in common between these nerves as evidencing pathological influences upon either or both. Quite frequently the presence or absence of loss of motion in the region of the eye serves to point the way to differentiation between central and peripheral locations of first causes in nerve disease. Therefore symptoms of ptosis, or falling of the upper eyelid, dilatation of the pupil and loss of reflex action to light and accommodation, turning of the eyeball outward and slightly upward, which are indications of *third nerve paralysis,* may call for careful oral examination in at least a supplementary way or be of value in preventing attempted local care of central disease.

Patheticus Paralysis.—Patheticus paralysis is a rare affection due to paralysis of the fourth nerve. It causes double images. When isolated, paralysis of the fourth nerve exists without affection of the third or sixth nerves. It is an important symptom of tumor of the cerebellum.

Paralysis of the Sixth Nerve.—Abducens Paralysis.—Paralysis of the sixth nerve is a frequent evidence of intracranial disease. Its characteristic symptom is internal strabismus, or turning of the eye inward, with inability to turn the eye outward, due to paralysis of the external rectus muscles. This nerve supplies the unopposed contraction of the internal rectus. It is accompanied by double vision and may also be associated with various forms of ocular palsy. The cranial course of the sixth nerve is so long that it is likely to be affected by disease at any part at the base of the brain. Its symptoms therefore require due

consideration in the diagnosis of many pathological conditions pertaining to both fifth and seventh nerves as well as affections of the third or sixth and in cases of brain tumors.

Symptoms.—Acute ophthalmoplegia, a disease of the nuclei of the nerves that supply the muscles of the eyeball and causes their paralysis usually begins suddenly with severe cerebral symptoms, vertigo, vomiting, headache, and sometimes delirium and coma, accompanied by paralysis affecting the action of the pupil or of motion of the eyeballs when the levator palpebræ are affected. (Ophthalmoplegia externa, Fig. 110.)

FIG. 110.—Patient suffering from chronic ophthalmoplegia externa. The wrinkling of the forehead in the effort to open the eyes is noticeable. The external strabismus can be seen. (After Starr.)

Prognosis.—In all forms of paralysis of the eye muscles when symptoms of bulbar paralysis develop the result is usually fatal. Otherwise there may be relief in the course of one or two weeks, or a chronic, slightly improving paralysis extending over a period of years. In the chronic form there may be gradual development of bulbar palsy, or extension of paralysis to other regions, or recovery in the large majority of cases if the ophthalmoplegia is only partial.

Treatment.—The treatment of lesions of the third, fourth, and sixth nerves properly belong with other fields of practice, except insofar as the oral surgeon may be able to contribute to general healthfulness or to the relief of local irritations which may tend to aggravate the condition.

DISEASES OF THE FIFTH OR TRIGEMINAL NERVE.

General Consideration.—In order to facilitate better understanding of each of the many diseases of this nerve, those affecting its principal

divisions are separately described, but it must be remembered that since both motor and sensory portions of the nerve are so commonly

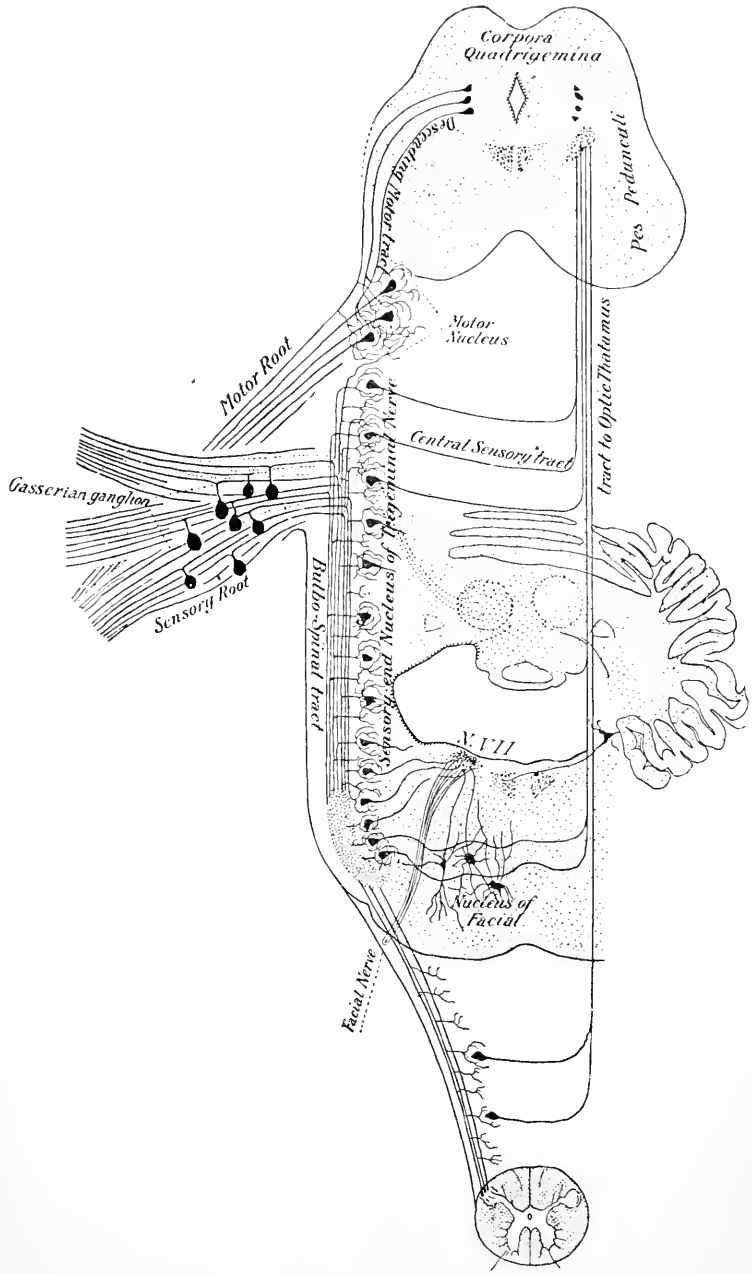


FIG. 111.—Scheme of the neurons making up the fifth or trigeminal nerve. (Edinger, after Starr.)

involved, especially when the Gasserian ganglion is affected, an exact division of pathological evidences of disease is impossible. Quite commonly *spasmodic contraction* of the muscles is associated with pain. In like manner, *trophic disturbances* may be evidence of disease affecting either or both divisions. The same is true of irritations, such as herpes, acne, or eczema, flushing or paling of the skin, alteration of temperature and appearance of the skin surface, unusual activity of the sweat glands, atrophy, or altered development. Consideration of the causes and treatment of these affections is necessarily a part of the description of the diseased conditions with which they are associated (Fig. 111).

Degeneration.—Degeneration takes place in this as in other nerves and nerve structures, and the same general or local causes come into consideration. As a result of injury there may be compression without rupture of the sheath of Schwann, which drives the myelin away from the point of pressure and causes degeneration of the axis-cylinder, or with the sheath of Schwann ruptured, exudation of the myelin occurs with consequent degeneration of the axis-cylinder. Following these changes there is an increase of nuclei and connective-tissue fibrils, with tendency to transformation of the nerve into connective tissue. At the point of division a bulbous growth of connective tissue forms a sensitive scar.

Nerve Regeneration.—Nerve regeneration is important in its bearing upon the continuance of relief from operations for tic douloureux, and the possibility of surgical anastomosis or spontaneous correction of results from disease or injury. Clinically, it is well known that some sort of regenerative process does take place when nerves are severed. Whether it is by a continued growth and extension of the nerve fibers from the central portion as claimed by Ranvier and others, or because protoplasm with specific developmental properties forms and unites the elements of the new fiber to the old one, as claimed by Neumann, may be a matter of question. Bowlby,[1] however, found regenerating nerves in the peripheral portion in three cases some months after operation, and the quite common practice of surgical anastomosis of nerves with strands of catgut, with favorable results, demonstrates the clinical possibilities of regenerative processes.

AFFECTIONS OF THE MOTOR PORTION OF THE FIFTH OR TRIGEMINAL NERVE.

Paralysis.—Injury or disease of the motor portion of the trigeminal nerve is evidenced by paralysis of the muscles of mastication. The lower jaw falls open and the acts of swallowing or speech become difficult or impossible. Unless, however, both sides are affected, there will be sufficient activity of the muscles upon the opposite side to prevent complete loss of action.

[1] Starr: Nervous Diseases, Organic and Functional, 4th ed., p. 165; Injury of Nerves, p. 25.

Deafness and tinnitus aurium (page 300) may result when the small branch of the motor portion which passes to the tensor tympani from the otic ganglion is paralyzed, because tightening of the ear-drum is thus prevented. Paralysis of the sphenostapedius muscle may cause a slight difficulty in swallowing, with deviation of the uvula toward the paralyzed side, due to paralysis of the muscles about the hard palate, through paralysis of this muscle, which is connected with the motor branch of the trigeminal nerve. These symptoms follow division of the motor branch when this occurs in operation for trigeminal neuralgia (page 258), and as a matter of course the motor branch should be avoided if possible (Fig. 114).

FIG. 112.—Hemiatrophy of the face. The condition had developed in two years. (After Starr.)

FIG. 113.—Hemiatrophy of the face. The condition developed slowly during five years, and then came to a stand-still at the point shown. (After Starr.)

Hemiatrophy of the Face.—Paralysis of the muscles which depend upon this nerve for motor activity sometimes leads to a gradual facial atrophy, and through the effect of muscle degeneration causes gradual sinking in of the facial features upon the affected side. This is differentiated from true facial hemiatrophy, because in the latter the muscles are not paralyzed and there is no marked loss of sensation, although there is a slowly progressive atrophy which affects all of the tissues, including skin, fat, muscles, and bones. This affection is rare, and its pathology practically unknown. It usually appears before the age of ten years, and rarely after twenty. The general effect is asymmetry of the face, which gradually becomes more and more evident until in natural course its progress ceases. A fatal termination does not result, and it therefore is distinguishable from muscular dystrophy, which has a tendency to fatal termination, and because there is no associated

muscular paralysis. It seems reasonable, however, to suppose that there is some analogy between the etiological factors which act as

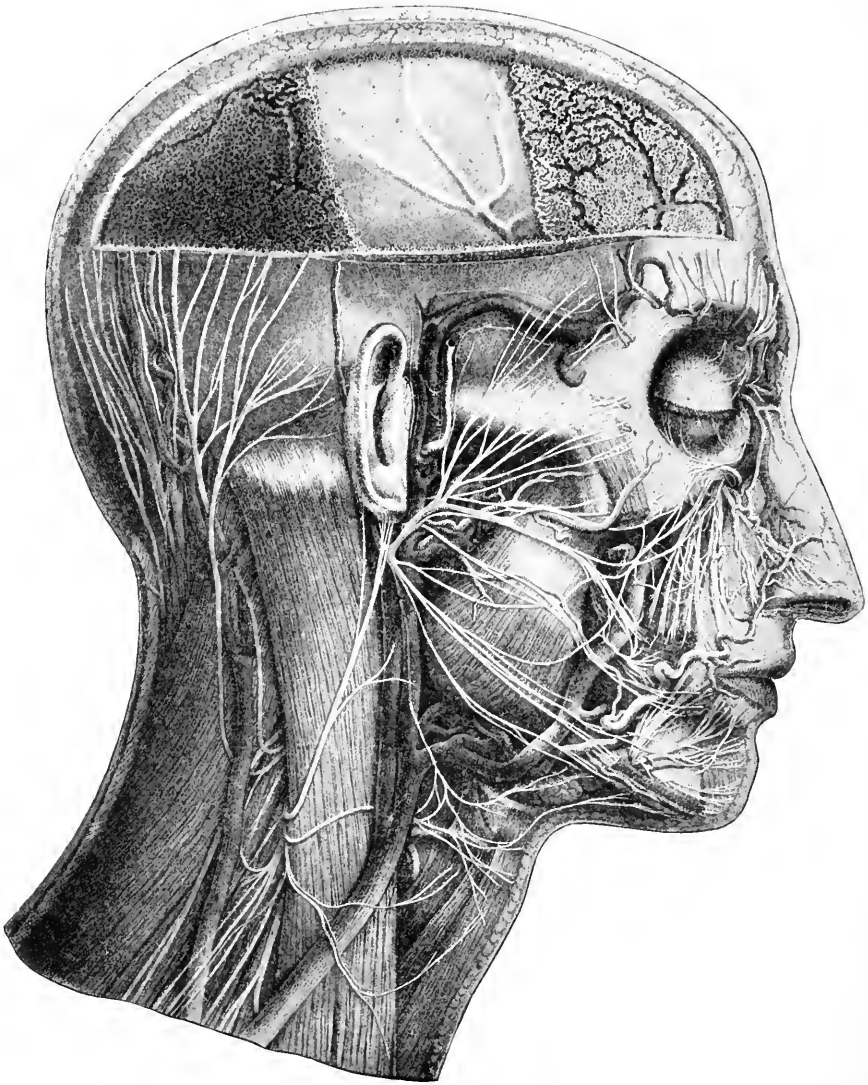


FIG. 114.—Showing the distribution of the fifth, seventh, and eleventh cranial nerves and the cervical and brachial plexuses; also the area of the middle meningeal artery in the inner table of the skull, injury to which is sometimes the cause of hemiplegia; also the course of the bloodvessels in the neck and face. (Arnold's Atlas.)

predisposing or exciting causes in the several forms of facial atrophy (Figs. 112 and 113).

HABIT AND OTHER SPASMODIC AFFECTIONS OF THE MUSCLES SUPPLIED BY THE MOTOR DIVISION OF THE FIFTH NERVE.

Spasm of Muscles of Mastication.—Trismus, or tonic spasm of the muscles of mastication, is usually associated with general convulsions or tetanus (page 90), and in these cases is not properly a local disease of the motor branch of the fifth nerve. Spasmodic affections of the muscles of mastication which occur in connection with facial or other spasms are also to be excluded for the same reason (page 309).

Etiology.—Direct irritation of the trigeminal nerve from impacted third molars and other teeth is quite a common cause of tonic spasm of the masseters. These and other causes, such as long-continued dental operations, irritation from inflammatory conditions, results of paralysis, hysteria, etc., are treated more at length (page 309). Clonic spasm of the muscles of mastication occurs in many different forms in greatly varying degrees and from widely different causes. It may be evidenced by chattering of the teeth during chills or fear, or be a symptom of paralysis agitans. Grinding the teeth, particularly at night, is a well-known symptom of many affections of childhood, which directly or indirectly disturb the nervous system, such as intestinal irritations from worms, indigestion or similar affections, adenoids and enlarged tonsils, irritating conditions of the eye or ear, or of the genitals, or any similar form of reflex irritation, and particularly pathological dentition (page 59). It is sometimes a sign of irritation at the base of the brain, and notes the beginning of tubercular meningitis. Tumors at the base of the brain or any of a variety of diseases may be so slight as to be safely outgrown or lead on to serious or fatal termination. In adults the habit of tooth grinding is an important factor from both causative and complicating aspects in many nervous affections (page 280). It is also important when concerned in habits of biting the cheeks or lips as leading to possible degenerative changes in the tissues subject to these chronic irritations.

Herpes Zoster.—Herpes zoster upon the face is sometimes associated with congenital paralysis of the trigeminal, and may result from diseased conditions of the Gasserian ganglion, injury of the fifth nerve, or pressure upon the base of the brain by tumors. Syphilitic or tubercular exudation in the meninges may be associated with symptoms of the bulbar paralysis of syringomyelia, as described on page 198.

Treatment.—The treatment of the foregoing diseases affecting the motor branch of the fifth nerve, insofar as they may be amenable to therapeutic measures, depends chiefly upon a diagnosis which will lead to discovery of the cause and to correction. Aside from the general upbuilding which all such patients require, remedial efforts must be directed to relief of the causative factor, and such hope of improvement as there may be necessarily depends upon the possibility of successful accomplishment in this direction. General treatment

must be given for causative or complicating constitutional pathological states, and this supplemented by hygienic care, electricity, massage, or other efforts to bring about improvement of nervous conditions. Chief dependence must be placed upon diagnosis and the treatment of local affections which may cause peripheral irritation in the distribution of the nerve. These are identical with those which cause other forms of disturbance, and are grouped and considered on pages 280 to 289.

AFFECTIONS OF THE SENSORY PORTION OF THE FIFTH OR TRIGEMINAL NERVE.

Hyperesthesia.—Hyperesthesia consists in excessive sensibility or impressibility. Hyperesthetic areas of skin surface, exceedingly painful to touch, are quite frequently associated with trigeminal neuralgia. Among the author's patients, persons of otherwise cleanly habits have been unable to wash their faces for weeks or months because of the painful sensation this excited.

Paresthesia.—Paresthesia is characterized by a tingling and numbness of the skin and mucous membrane felt in the distribution of the sensory filaments of the nerve. Such sensations are usually felt in the extremities, but are not infrequent in certain portions of the mouth, particularly along the side of the tongue.

Etiology.—Numbness of this character in the extremities, as, for example, when the foot or hand is said to be asleep, is caused by pressure upon the nerves during sleep or otherwise, and may be a first symptom of the onset of some more serious affection. In the distribution of the fifth nerve the cause is frequently irritation from dental pulps or pericemental inflammation due to malocclusion, jaw-biting habits, and similar affections.

Pathology.—There is slight impairment of nutrition in the nerve caused by venous congestion.

Symptoms.—The numbness may be of transitory nature, may last for short periods but recur frequently, or may be almost continuous and in time lead on to true neuritis.

Treatment.—The treatment consists in relief of the local irritation whenever such cause may be discovered. The author believes paresthesia to be a much more important symptom in the fifth nerve distribution than is usually understood. In a considerable number of his cases it has been found to be a first indication of reflex irritation from dental pulp disease, or tooth-crowns that have been inserted injudiciously or unskilfully without due regard for occlusion. For example, a young woman, aged about thirty years, a seamstress, was so troubled by numbness along the side of her tongue that it began to prey upon her mind until it became a very important irritating factor in connection with a condition of general nervous debility with symptoms of neurasthenia. Examination disclosed a piece of bridge-work that had been

inserted by a dentist some months before, upon which were bright worn spots upon the occlusal surfaces, such as in gold crowns, bridges, and fillings always indicate malocclusion and the results of tooth-grinding. The removal of this bridge-work and treatment of the pulp of a molar tooth that had been crowned by one of the gold caps gave relief from the distressing symptoms, and this, supplemented by tonics and good general care, brought about a restored condition of health with marked increase in weight. After a period of rest an attempt was made to restore the bridge-work in the belief that it might then be safely tolerated in the mouth, but a prompt recurrence of the numb sensation in the tongue made removal necessary.

Anesthesia.—Paralysis of the sensory portion of the fifth or trigeminal nerve.

Etiology.—It may be due to any pathological condition involving the Gasserian ganglion or one or more branches of the nerve, operations upon the Gasserian ganglion and resections and other operative procedures upon the nerve, traumatic injury to the nerve structures, laceration incident to the removal of impacted third molars or other teeth, resections of the jaws, removal of large sequestra of necrosed bone containing more or less important branches of the nerve and similar conditions.

Symptoms.—The symptoms include numbness and anesthesia of the parts supplied by the nerve, including mucous membrane surfaces. This numbness is sometimes accompanied by a prickling sensation which is occasionally very distressing to the patient. Food collects between the teeth and cheeks. The facial muscles are affected in their normal activity through loss of muscle-sense by reason of the lack of normal sensory stimulation and the guidance which sensation gives. Occasionally this is so great as to simulate Bell's palsy. In the graver cases there may be increase or decrease in the flow of saliva, tears, nasal and oral mucus. These alterations sometimes lead to secondary ill effects, such as impairment or loss of sense of smell through change in the Schneiderian membrane. Ophthalmic changes may occur in a similar way. Among these symptoms a distressing feature is alteration of the sense of taste which is lost or at least seriously impaired over the anterior two-thirds of the tongue and to some extent at the posterior portion of the tongue. The glossopharyngeal nerve is credited with supplying gustatory sensation to the posterior portion of the tongue, and the chorda tympani to the anterior two-thirds, but the connection between the chorda tympani and the brain as to whether it passes by way of the trigeminus or by the facial or glossopharyngeal arch is still unsettled. Evidence favoring both theories has been presented by many authors in observation of results of operations on the Gasserian ganglion, lesions involving the facial nerve, and the pars intermedia between the geniculate ganglion and the pons. Cushing has reported 13 cases of total extirpation of the ganglion with only 1 in which taste perception failed to be reëstablished, and in this case the

chorda tympani had been divided at a previous operation. Thus it would appear that the taste fibers do not pass exclusively by way of the trigeminal nerve to the brain. The opposite view is, that the fibers of the chorda tympani pass through the geniculate ganglion by way of the pars intermedia to the brain in association with the facial nerve, but it is a notable fact that lesions of the facial nerve involving the pars intermedia do not usually affect the sense of taste. Therefore it seems fair to conclude that there are individual differences and that the taste fibers do not reach the brain in the same way in all persons. From a surgical point of view this is undoubtedly the safer ground to take.

Pain.—Pain occurs in a great variety of forms and may be at the point of injury or include all of the distal portion of the affected division of the nerve. It may also be reflected to other divisions and manifest itself at some point quite distant from the actual lesion or source of irritation.

Headache.—Pain in the head is caused by disturbance of nutrition of the brain, and may be a notable feature of syphilitic meningitis and other diseases of the brain structures and nerves, as well as of many other general conditions. The character, form, period of continuance, and treatment of such headache is necessarily governed by the disease of which it is a symptom.

Symptoms.—It may be sudden, sharp, and excruciating, and of short duration, or continue for hours, or may appear in many other forms. It is distinguished from the pain of neuralgia because it is not limited to a particular nerve trunk, and from migraine, as usually considered, because it is not unilateral and does not occur periodically.

Migraine.—Migraine or periodical headache, according to Starr, Dunglison, and many others, is considered as identical with hemicrania or periodical unilateral pain in the head. Jelliffe,[1] however, describes it with certain reservations as follows: "Migraine may be defined as a periodical abnormal state in which the patient suffers from a peculiar oppressive pain in the head, unilateral or bilateral, localized or general, which develops very gradually from heaviness or dulness, to pain that is splitting." The tendency of the modern writers is to discard the unilateral feature and consider it as an affection which may be unilateral or bilateral. Usually with these attacks there are certain symptoms which have given rise to the use of the term "ophthalmic migraine," a form of nervous disturbance accompanied by headache and associated with disordered vision.

Etiology.—Heredity bears an important relation to this affection and is one of the most common predisposing influences, the family history showing other members to have been affected. It rarely affects infants, but sometimes begins at about seven to nine years of age, though it usually occurs at puberty. Faulty metabolism, whether due to some congenital defect in the chemistry of nutrition or to an acquired

[1] Osler: Modern Medicine, 2d ed., vol. v, 1915.

derangement of metabolic processes, is undoubtedly the principal cause, and, as might be expected, disturbance of digestion, autotoxemia, gout, arthritis, and similar factors with varying degrees of importance, as anemia, want of outdoor exercise, sedentary habits, indoor, confining, nerve-exhausting, eye-straining, and otherwise trying occupations are contributing elements.

Visual Defects.—Walton[1] considers it to be an occupation neurosis, resulting in individuals of neurotic inheritance from overuse under the handicap of refractive error of the parts concerned in vision. Gradle[2] does not agree with this. He holds that sometimes refractive error is of vital importance in these cases and sometimes it is not, and gives the following results in treatment of 90 cases which are extremely instructive: 22 practically cured by glasses; 22 benefited by glasses; 31 not benefited by glasses; 15 not requiring glasses (except simple convex spheres).

There is quite commonly a premonitory sensation of scotomata, which has been likened to the aura of epilepsy, and for this reason migraine has been classed as of "epileptic character" by some authors, but this view in its full sense is not generally accepted, the chief argument being such large numbers of people are affected in whom there is no evidence of epileptic tendency.

Symptoms.—The attack may be ushered in by certain premonitory symptoms, such as scotomata and other visual signs. There may be partial blindness, temporary aphasia, numbness, loss of memory, dulness of mental activity, a sense of chilliness, nausea, tinnitus aurium, modifications of taste, smell, or touch, and a peculiar oppressive pain in the head which may be localized or general, developing from dulness until it may become intensely severe. The frontal and temporal regions are most often involved, the occipital next, and the vertex seldom ever alone. During the attacks the patients are somnolent and sleep for hours and even days. Attacks may occur biweekly or within intervals of only a few days, monthly, as with many women, or at longer intervals.

Diagnosis.—The history of the case may usually be depended upon for differentiation from other forms of headache, the ophthalmic and other sensory symptoms distinguish it from the different forms of trigeminal neuralgia.

Prognosis.—The probability of complete relief is small; the frequency and severity of attacks may usually be benefited by change of habits of life and treatment. Usually the attacks subside at about the age of fifty, after the menopause in women, and sometimes after ovariotomy.

Treatment.—Regulation of diet is a matter of first importance. Good hygienic care, including exercise, baths, and proper massage, with lots of good air and outdoor exercise, are also helpful. There should be thorough cleansing of the bowels, and in anemic patients ovoferrin or some similar preparation to improve the red blood cor-

[1] Jour. Am. Med. Assn., June, 1908, p. 202. [2] Ibid.

puscles or tonics should be given. Washing the stomach with some alkaline solution is recommended to abort attacks. For the relief of pain, heat should be applied to the feet and ice-packs to the head; a soothing rubbing which will tend to carry the blood toward the extremities and the use of antipyretics are indicated. Morphin by hypodermic will of course give relief, but is to be avoided if possible because of the danger of acquiring the habit. For the relief of the symptom of tooth-grinding and the incidental irritation with consequent increase of pain, an appliance devised by the author, and called a "soft-rubber bit," has given much relief and assisted in overcoming the habit in many cases. This appliance is illustrated and described on page 291.

NEURALGIA.

Trigeminal Neuralgia.—Neuralgia is a disease of a sensory nerve characterized by pain in the course of the nerve or in its peripheral distribution.[1]

The trigeminal nerve is distributed over a wide area, and the bony canals through which its several branches pass expose it to injury not only in the terminal ends of the nerve itself, but there is also the likelihood of fracture, compression, or maldevelopment of surrounding bone structures. It is in close association with other cranial nerves through which it may become affected. The twenty-two teeth of the deciduous set, and the thirty-two of the permanent, which are supplied by its branches, all have pulps and surrounding pericemental structures which are quite commonly diseased and therefore frequent sources of irritation. For these reasons this nerve, as might be expected, is the one most frequently affected by neuralgia. The affection occurs more often in women than in men. It may begin at almost any period of life, but is more frequent in its serious aspects in middle or later life.

Classification.—The types of this affection classified in accordance with its clinical aspect are:

Neuralgia Minor.—This, as its name implies, represents the less severe forms, and may usually be described with the name of the affected branches of the nerve.

Visceral Referred Pain, Reflex, or Symptomatic Neuralgia.—The irritation, of which the reaction of the nerve system is an expression, may be referred from the teeth, the eye, ear, nose, tongue, and other organs associated in the fifth nerve distribution.

Neuralgia Major; Tic Douloureux; Epileptiform Neuralgia.—This is the generic term for a very acute, exacerbating, or intermitting, throbbing pain, which follows the course of a nerve, extends to its ramifications, and seems, therefore, to be seated in the nerve.

The terms *symptomatic* and *idiopathic*, as sometimes used in classification by grouping under the former term the two first types and the

[1] Starr: Nervous Diseases, Organic and Functional, 4th ed., p. 729.

third under the latter, appear to be too indefinite and not quite in accordance with recent advances in the study of the pathology of tic douloureux.

Etiology.—The factors which may be concerned in causing the various forms of trigeminal neuralgia are so numerous, their character is so widely different, and their importance in directing methods of treatment so great that division into groups according to pathological similarity is necessary.

The following classification of causes is a modification of one first suggested by Wm. Rose and quoted by Murphy and Neff:[1]

I. INTRACRANIAL.

(*a*) Cerebral:
1. Sclerosis.
2. Aneurysms.
3. Tumors involving some part of the extent of deep origin of the nerve.

(*b*) Radical:
Any inflammatory affection of the sheath of the root.

(*c*) Ganglionic:
Chronic interstitial inflammatory changes causing compression on the nerve cells.

II. CRANIAL.

1. All morbid processes at the base of the skull and in foramina.
2. Callus following fractures.
3. Syphilitic periostitis.
4. Inconstancy of shape and size of foramina.

III. EXTRACRANIAL OR PERIPHERAL.

1. Dental caries: diseases of the dental pulps, pericemental, and dento-alveolar affections.
2. Contraction of lumina or peripheral bony canals.
3. Exposure to cold or damp, producing perineuritis; atmospheric conditions.
4. Retention of secretion in frontal, maxillary, sphenoidal, or ethmoidal sinuses.
5. Diseases of the eye, ear and nose; nerves cut in cicatrices, impacted foreign bodies, malposed unerupted teeth, spiculæ of bone, etc.
6. Traumatism.

[1] Jour. Am. Med. Assn., October 11, 1902, p. 897.

IV. TOXIC, REFLEX AND FUNCTIONAL CAUSES.

Among these are included neurotic temperament, worry and anemia, malaria, digestive disturbances, sepsis, diabetes, la grippe, febrile diseases, rheumatism, gout, pregnancy, hysteria, alcoholism, uterine or ovarian affections, and the influence of any general disease that may predispose by causing a debilitated condition of the system, and also lead, mercury, arsenic, nicotin, and similar poisons. In the great majority of cases the disease process is ascending, beginning in the peripheral nerve filaments and later progressing to and involving the ganglion. In a few cases, however, probably including those benefited by an extirpation of the ganglion, the lesion has been central, either in the area of distribution of the sensory root or in the sensory root itself.

Heredity plays no part in the etiology, though in some cases neurotic history is obtained.

The foregoing may be either predisposing or exciting causes, or both, but it seems best not to attempt any radical distinction of this character in classification such as is given by some authors, because our present knowledge of the varying degrees in which causal influences may be effective does not warrant a distinct line of demarcation.

Pathology.—The pathological alterations which might be accepted as being distinctively representative of neuralgia of the fifth nerve are indefinite. Certain changes in Gasserian ganglia which have been removed have been demonstrated by Cushing, Spiller, and others, but while it is recognized that trigeminal neuralgia may be due to central causes such as disease of the pons, hemorrhage, softening, multiple sclerosis, tumor, or abscess, through which the Gasserian ganglion or the fifth nerve may become involved, it is also caused by peripheral irritation, and in these cases pathological manifestations might be confined to affected branches of the nerve, and the Gasserian ganglion

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DESCRIPTION OF PLATE X.

Fig. 1.—Portion of the Gasserian ganglion at the entrance of the third branch of the trifacial nerve. The medullary sheaths are most irregularly swollen, and at the right of the field empty nerve sheaths are seen (method of Azoulay).

Fig. 2.—Portion of the second branch of the trigeminal nerve near the Gasserian ganglion. The axis-cylinders have entirely disappeared, and the medullary sheaths are greatly swollen. In many places the medullary substance of two or more nerve fibers has united into irregularly shaped masses (osmic acid stain).

Fig. 3.—One of the nerve bundles within the Gasserian ganglion. Numerous swollen and irregularly formed axis-cylinders may be seen. In most portions of the field these appear as drops of a red, hyaline-like substance, but in one portion an axis-cylinder of considerable length may be seen.

Fig. 4.—Bloodvessels from the Gasserian ganglion. The walls are greatly thickened, and the lumen of the large vessel has been almost entirely obliterated. In one place the innermost layers of the vessel have contracted from the outer during the process of hardening. Smaller vessels in the upper part of the field are entirely closed.

Fig. 5.—A nerve bundle of the trigeminus close to the Gasserian ganglion. Only a few nerve fibers are present, and everywhere an abundance of connective tissue is seen. Three much swollen medullary sheaths are in the field. (After Starr.)

PLATE X

FIG. 1

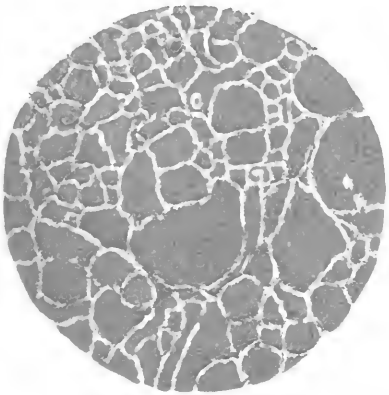

FIG. 2

FIG. 3

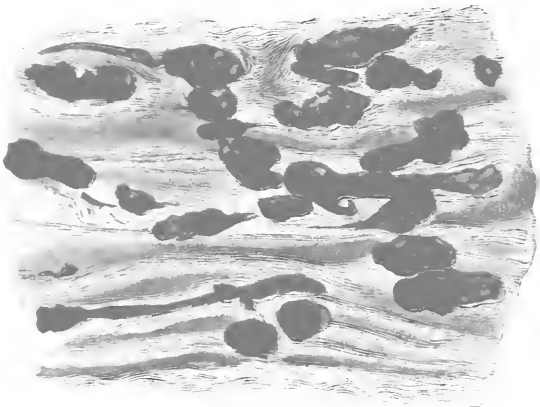

FIG. 4

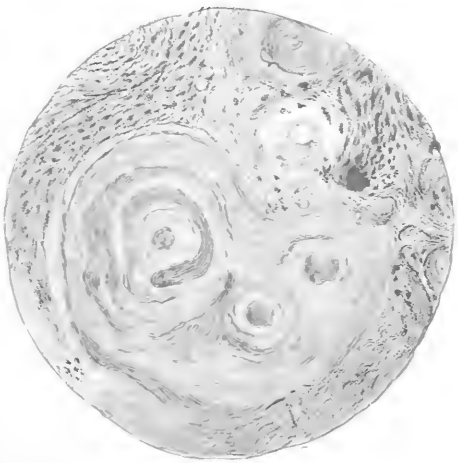

FIG. 5

would probably not give any indication of pathological structural alteration. Certain changes, however, which take place in the pulps of otherwise normal teeth in these cases (Figs. 115 and 116) lend color to the belief that there is always structural alteration in the nerve or its affected branches in greater or less degree, and that in the course of time, with progress of the disease, other more remote portions of the nerve undergo similar degenerative changes. Gordon[1] believes that peripheral nerve degeneration is constantly present, and that this degeneration assumes the form of a neuritis which secondarily involves the Gasserian ganglion (Plate X).

Changes in the bloodvessels, indicative of arteriosclerosis, are frequent associates of this affection in patients of advanced age.

Fig 115.—Pulp showing calcific degeneration removed from a molar tooth upon the affected side in a case of tic douloureux.

Symptoms.—The essential symptom of neuralgia is pain. Usually the pain is described as paroxysmal, but in minor neuralgia or visceral referred pain in the distribution of the trigeminus, painful symptoms may appear in many forms. It may be more or less continuous, appear and disappear quickly, or show a tendency to periodic manifestations, as at particular hours of the day, certain days of the month, or under special conditions of almost any kind; it may be excited by certain acts, the position of the body, as in lying down or standing, and by moments of excitement or atmospheric changes. Usually

[1] Practical Medicine Series, 1906, x.

in minor neuralgia, especially at the beginning, the pain is confined to the particular branch of the nerve that is most affected by the peripheral irritation, whatever it may be, and the neuralgia is described as supra-orbital, infra-orbital, temporal, frontal, occipital, etc. Visceral referred pain has a tendency to appear in distant and otherwise unaffected parts. Other reflexes may also be associated with the pain. There may or may not be hyperesthesia or superficial tenderness over circumscribed areas of skin or mucous membrane surfaces (Fig. 117).

FIG. 116.—Pulp showing calcific degeneration removed from a tooth upon the affected side in a case of tic douloureux.

Diagnosis and Treatment.—In the early stages of neuralgia it is sometimes difficult or impossible to distinguish between major and minor forms, and it is generally admitted that minor neuralgia of peripheral origin may progress until the central portions of the nerve are attacked. The diagnosis and treatment of all forms of trigeminal neuralgia therefore will be jointly considered.

Tic Douloureux.—Symptoms.—In the violent paroxysms which are indicative of this form of neuralgia there is more or less involve-

ment of all the functional elements of the trigeminal nerve. The symptoms that are expressive of all these effects naturally present themselves in two chief divisions: (1) *Sensory Manifestations.* (2) *Motor, Vasomotor, and Secretory Abnormalities.*

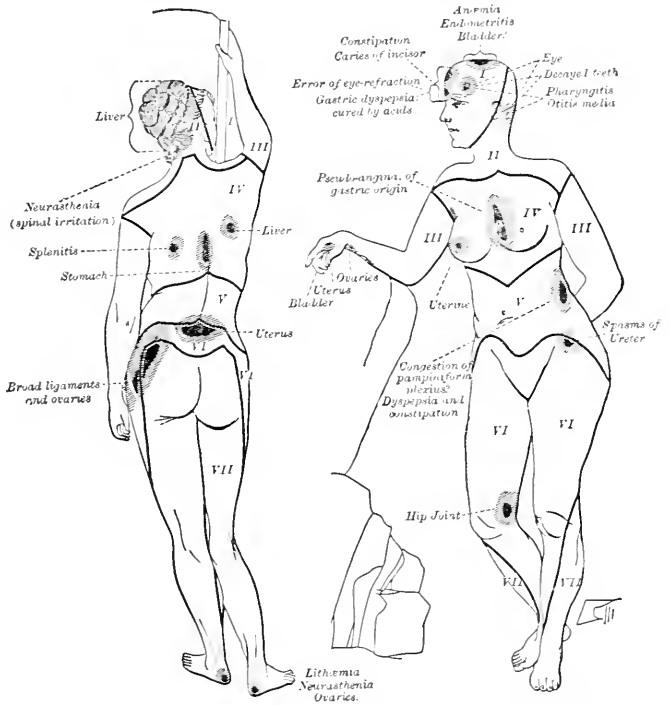

FIG. 117.—The locations of referred pains and their cause. (Dana, after Starr.)

Area.	Cerebrospinal nerves.	Distribution.	Associated ganglia of sympathetic.	Distribution.
I.	Trigeminus, facial.	Face and anterior scalp.	4th cerebral.	Head.
II.	Upper 4th cervical.	Occiput, neck.	1st cervical.	Head, ear.
III.	Lower 4th cervical and 1st dorsal.	Upper extremity.	2d and 3d cervical, 1st dorsal.	Heart.
IV.	Upper 6th dorsal.	Thorax.	1st to 6th dorsal.	Lungs.
V.	Lower 6th dorsal.	Abdomen, upper lumbar.	6th to 12th dorsal.	Viscera of abdomen and testes.
VI.	12th dorsal and 4th lumbar.	Lumbar region, upper gluteal, anterior, and inner thigh and knee.	1st to 5th lumbar.	Pelvic organs.
VII.	5th lumbar and 5th sacral.	Lower gluteal, posterior thigh and leg.	1st to 5th sacral.	Pelvic organs and legs.

Sensory Symptoms.—Pain, the all-important symptom, may be accompanied by its antithesis, anesthesia, or any one of a considerable variety of intermediate sensations; such as burning, prickling, itching, etc.

In the paroxysmal form which is typical of tic douloureux pain may appear at the very beginning without previous warning or appar-

ent cause, or it may begin with symptoms of minor neuralgia or visceral referred pain and gradually assume a paroxysmal character. The pain is unilateral, most frequently limited to the second and third divisions of the nerve, although it occasionally affects the first division and in advanced cases all the branches may be involved. It seems to occur more often on the right side than the left, and to affect women more frequently than men. The distinctive feature of pain in tic douloureux is the sudden onset of the paroxysms and more or less complete freedom from pain during the intervals between them. The intervening periods vary from a few seconds or usually a few minutes to hours, according to the progress of the disease and the condition of the patient. Both the intensity and length of duration of the painful attacks are also similarly governed. In the beginning there are often quite considerable periods during which no pain is felt, and at such times patients usually believe themselves to be improving, but almost always there is recurrence of the symptoms and usually with increased severity. This feature is sometimes deceptive in arriving at conclusions as to the result of treatment, and much error has undoubtedly arisen by reason thereof. The paroxysms may begin without apparent cause or be incited by very slight disturbance, such as draughts of cold air, slight motions of any kind, particularly in speaking, movement of the jaws, swallowing, laughing, or excitement of any kind. Sometimes the pain is confined to the daytime and the patient rests well at night; in other cases it continues both day and night. Occasionally the pain is preceded by a peculiar sensation variously expressed, and by some authors termed an "aura." But this is not always present, and the use of the term as in epilepsy does not seem to be fully warranted or generally accepted. Usually pain comes with the quickness of an electric current when the wires are brought in contact. It varies in severity, and is described as a feeling of being cut by red-hot knives, and of pricking, tearing, lancinating, or boring. It is usually more intense at points of exit of the nerves, such as the supra-orbital, infra-orbital, or mental foramina. In rare cases it extends to the opposite side, and when this occurs it is assumed to be of central origin. The suffering of these patients is beyond the possibility of description. Strangely enough, many of them retain reasonably good health in other respects, notwithstanding the continued pain, loss of rest, and other ill effects. In the course of time, however, through derangement of the nervous system, prevention of mastication of food by the pain thus excited, and loss of teeth, there is loss of flesh and general breaking down which renders such individuals pitiful objects.

Motor Symptoms.—The motor symptoms are evidenced by spasmodic contraction of the muscles of the jaw, face and head, or twitching of the facial muscles and those of the eyelids, also of the nose and angles of the mouth during the paroxysms of pain. There is often a drooping of the features upon the affected side which gives evidence of slight paralysis of the muscles (Figs. 118, 119 and 120).

Vasomotor Symptoms.—Vasomotor symptoms may appear as redness of the affected side of the face. Swelling, which much resembles angioneurotic edema, sometimes occurs during periods when paroxysms are frequent and does not disappear between the paroxysms,

FIG. 118.—Tic douloureux; paroxysm of pain.

FIG. 119.—The same man as shown in Fig. 118 after operation.

but remains for several days or longer and cannot be accounted for by any inflammatory condition. Distention of the veins, unilateral perspiration, changed appearance of the lips, and other similar effects are occasionally noticeable. The secretory aberrations are usually

FIG. 120.—Tic douloureux; effect of twenty-five years of suffering.

marked, tears flow from the eyes, and the secretion of saliva, as well as nasal mucus, is actively stimulated. The general picture is one of distress and pain.

Diagnosis.—The diagnosis of tic douloureux is usually clear, inasmuch as it differs from headache and other forms of neuralgia by its parox-

ysms and the intervals of freedom from pain and from other spasmodic affections by pain. The determination of whether the seat of the neuralgia is central or peripheral is most important. To determine this any associated symptoms or pathological indications which might lead to the recognition of brain affection or some general disease that might be accountable for central irritation should be carefully considered. Thorough search must be made to ascertain any peripheral cause that might exist. This includes careful examination of the eyes, ears, nose, and so far as possible the maxillary and other associated sinuses, as well as search for scars, results of traumatic injury, foreign bodies, and diseased conditions of the teeth. (The diagnosis of dental and oral forms of irritation are described on page 275.)

Since the cause may be looked for higher up in proportion to the number of divisions and subdivisions of the nerve that are affected, it necessarily follows that each of the several branches should be examined for evidence of pathological alteration.

In a general but somewhat practical way this may be tested by pressure at the points where the nerve passes through the foramina upon or near bone surfaces. For example: If pressure be made with a finger passed within the mouth along the inner surfaces of the ramus of the lower jaw over the point of entrance into the inferior dental foramina, or over the mental, the infra-orbital, or supra-orbital foramina, pain is excited if the disese is confined to one of the branches, and it will usually react along the line of the particular branch that may thus be irritated. If, however, pain excited at any of these or similar points is felt in other branches or throughout the entire distribution of the nerve, it is an indication that the degenerative process has progressed until all of these divisions have become involved, and in all probability this has occurred through involvement of the ganglion.

Treatment of Various Forms of Neuralgia.—The treatment of trigeminal neuralgia resolves itself into non-surgical and surgical methods. If constitutional diseases are found to be the underlying cause, these must receive proper attention. Every possible source of peripheral irritation must be removed, or the likelihood of its acting as an excitant guarded against. The eyes must be examined not only for visual defects, but for choked disk, partial or complete blindness, or other indication of brain affection, or any disease of the eye or its associated parts which might directly or indirectly be etiological factors. The nose and its secretions, membrane, septal, turbinal, or other deformities, should be examined and corrected if necessary. In like manner the ear and the frontal, ethmoidal, sphenoidal, and maxillary sinuses should be duly examined, and treatment applied if indicated. The mouth and teeth should be tested and treated as described on page 289. Habits of life must be duly considered and their correction directed. Ovarian, uterine, or other organic disease should be sought for and treated if necessary; the intestinal tract cleansed and duly regulated; digestive conditions safeguarded; and occupation, if disad-

vantageous, readjusted to give necessary relief. The general nervous condition must be patiently studied and insofar as possible controlled according to the best psychotherapeutic methods. The observance of thoroughly good hygienic rules must be insisted upon, including diet, abundance of fresh air, exercise, and massage.

Massage.—Care should be taken in giving massage to these patients to see that it is properly done. The usual rubbing given by nurses in hospitals cannot be depended upon, and occasionally does more harm than good in exciting the circulation disadvantageously. Such manipulations should be carried toward the extremities away from the head, and central regions, and be chiefly in the nature of a gentle stroking with sufficient muscular kneading to give continued effect and general stimulation, as well as rubbing along the spinal column. The personal effect of the one administering the massage in relation to the subject is important. The rubbing of one nurse or attendant may cause increased nervousness and wakefulness, with augmentation of the pain, while under the manipulation of another in almost precisely the same manner the same patient may feel rested, become relaxed and drowsy, with marked diminution, if not complete cessation, of the pain.

Medicinal Treatment.—Examination of twenty-four hours' urine for these patients quite frequently shows more or less marked variation from normal quantity, and almost invariably a high degree of acidity with marked increase of indican. The latter is a product of indol, which is a result of intestinal fermentation, and this state is usually further evidenced by tendency to constipation and other disturbances of the digestive tract. It therefore follows that this region should receive attention. Drinking water freely or the use of diuretics may be demanded. Purgation with calomel sometimes gives a measure of relief in certain forms of attacks.

Castor Oil.—The continued use of small doses of castor oil has been highly recommended as being more permanently beneficial. Its use is based upon the theory that such neuralgia is of toxic origin and that a prolonged evacuant treatment should benefit—two or three good-sized doses of castor oil every day for a period of two or three weeks. When the laxative effect has been thoroughly produced it ceases to give distress and serves a very effective purpose. This treatment was advocated by Strohmeyer in 1864.

Gelsemium.—Fifteen drops of the green tincture given every few hours for a few days, or until the physiological limit is reached, which will be noted by the patient beginning to see everything in yellow colors, is one of the highly recommended remedies.

Miscellaneous Drugs and Measures.—Hot foot baths and hot applications to the feet tend to draw blood from the head and to cause a general relaxation which is often very helpful. Applications of heat or cold or liniments over the affected region have a grateful effect. Many of these patients are anemic, and for these ovoferrin for improvement

of the hemoglobin or other tonics, and such general restoratives as quinin, cod-liver oil, or the phosphates are beneficial. Arsenic, potassium iodide, and mercury have their proper places in the list of remedies, especially when syphilis is suspected as a causative influence. Electricity, chiefly employed in the form of electrolysis and a high-frequency current, has a measure of value, and has been highly recommended. Its possibilities, like those of the *x*-rays and radium, also well recommended, have yet to be definitely determined. Hypnotic drugs should only be given as a last resort, and then only with the greatest care of administration, because the tendency of all these patients is ultimately to seek relief of this character, and the danger of the drug habit is always a menace. Bromides, chloral, opium in its various forms, especially codeine and morphin, and other similar remedies are all capable of giving temporary relief, but when once dependence has been placed upon them the demand becomes more constant and the required doses larger until, with almost unfailing certainty, disaster follows.

Antipyrin, phenacetin, and salicylates have an undoubted place, especially with rheumatic persons. In a general way, however, it may be safely stated that when no relief can be given by measures which without harm in other respects tend to restore normal physiological function in deranged parts, upbuild general health and resistance or correct nervous states, or when no actual peripheral cause can be discovered through correction of which relief may be given, then, instead of relying upon drugs, the only rational treatment must be in the nature of injections into the nerve at accessible points in the course of the affected branches, or operations upon the nerve or the Gasserian ganglion.

The Injection of Osmic Acid Directly into the Nerve.—A 1.5 per cent. solution has been advocated by Bennet, Murphy, Hammerschleig, and others with reports of cases benefited. Its effectiveness depends upon two factors—the destruction of nerve filaments and their substitution by connective tissue.

Favorable results from the use of osmic acid in 9 patients are reported by R. Hammerschleig.[1] A 1 per cent. aqueous solution was injected into the infra-orbital and mental foramina. In 8 of the patients the pain has not recurred for intervals varying from four months to as many years; in the last case there was great improvement.

Murphy claims that the osmic acid gives a longer period of relief on the average than any method except removal of the ganglion or the metallic plugging of the foramina. He reports a number of his cases as well after the lapse of four years.

As long as a feeling of numbness which gives a measure of discomfort is felt in the region supplied by the injected branch of the nerve in cases where the trouble is confined to the division so treated, there is relief

[1] Arch. f. klin. Chir., 1906, lxxix, 1050; Practical Medicine Series, 1907, x, 181.

from pain. When, however, the patients report that the face feels quite natural again, it usually follows that pain quickly returns.

Injections of Alcohol.—Alcohol by deep injection into the nerve trunk was first performed by Schlösser, of Munich. The method of performing has been improved by Otswald, Levi, Baudouin, and Patrick. From 70 per cent. to 90 per cent. alcohol is used with a little cocain or stovain to prevent pain or discomfort from the injection. Patrick's[1] alcohol solution is as follows:

℞—Cocain hydrochlorate	gr. j
Chloroform	♏x
Alcohol	ʒiv
Distilled water, sufficient to make	ʒss—M.

Of this he injects 2 c.c. For succeeding injections the proportion for alcohol is increased gradually up to 90 per cent., the amount of cocain being also increased.

The instrument is a needle of large caliber, about 12 cm. long, marked off in centimeters up to 5, beginning at the point. This is fitted with a stylet of such length that when pushed home the end is flush with the point of the needle. For the injection a syringe holding 2 c.c. is employed, the nozzle of which will fit snugly into the end of the needle.

For the inferior maxillary branch of the fifth nerve the needle is inserted at the lower border of the zygoma, 2.5 cm. in front of the anterior border of the external auditory meatus. The bony ridge of the temporal bone, as well as the descending root of the zygoma, can always be felt along the front border of the meatus. The stylet is partly withdrawn, the point of the needle pushed through the skin and subcutaneous tissue, and the stylet is then pushed home, so that for the remainder of the penetration the blunt end of the stylet serves instead of the sharp point of the needle. This is to prevent the possible transfixion of bloodvessels. The needle is then pushed inward in a plane at right angles to the side of the face and inclined a little backward to the depth of 4 cm. At that depth the point should reach the inferior branch of the fifth nerve as it emerges from the foramen ovale. The stylet is then withdrawn, the syringe fitted to the needle, and the injection slowly made.

For the superior maxillary division of the fifth, the point of entrance is at the lower border of the zygoma, 0.5 cm. posterior to the point which would be reached by prolonging downward the line of the posterior border of the perpendicular process of the malar bone. From this point the needle is passed almost perpendicularly inward, being inclined forward and upward. At a depth of 5 cm. the point should reach the nerve at its emergence from the foramen rotundum into the sphenomaxillary fossa.[2]

The author modifies Patrick's procedure by injecting novocain with a small syringe at exactly the point and in the direction to be followed by the large caliber needle and stylet. This is done by

[1] Practical Medicine Series, 1907, x, 172.

[2] Ibid., x, 169.

injecting a little novocain just under the skin, and from time to time, as the point of the needle penetrates. By carrying the needle in, almost but not quite, to the point to be reached by the alcohol injec-

FIG. 121.—Illustration of the point of entrance and direction of the cannula and stylet for injection of the superior maxillary division of the fifth nerve at the foramen rotundum—is calculated from a point 1 cm. posterior to the external angular process in a direct line downward to a point just below the zygoma. The point is inclined forward and upward, and forced in to a depth of 5 cm. Care must be taken to have the patient look upward to avoid possible injury to the eye muscles. The author prefers to have the patient lie on the opposite side with the head supported on a pillow, to facilitate accuracy in the direction of the syringe point.

tion, the insertion of the large syringe is rendered much less painful. Care must be taken, however, not to penetrate deeply enough to anesthetize the branch of the nerve to be injected. Even though the

FIG. 122.—Injection of the inferior maxillary division of the fifth nerve at the foramen ovale 2.5 cm. in front of the external auditory meatus. The point is forced straight in to a depth of 4 cm.

point of entrance, the direction, and the depth of the injection may be ever so carefully calculated, slight anatomical differences in individuals renders it necessary that the sharp pain must be felt when

the syringe point reaches the foramen ovale or the foramen rotundum. The radiation of pain throughout the area of distribution of the injected nerve gives certain indication that the objective point has been reached. (See Figs. 121 and 122.)

Diseases of the sphenopalatine or nasal ganglion have been described by Dunn[1] and Sluder.[2] Sluder says that such attacks of pain resemble those of maxillary and vidian neuralgia excited from within the sphenoidal sinus. If due to an affection of Meckel's ganglion cocainization of this structure gives relief, which is not the case when it originates from the sphenoidal district. Applications of 2 per cent. silver nitrate or 1 per cent. formaldehyde to the membrane of the sphenopalatine foramen often cure the mild and subacute cases, while in severe ones injections of alcohol are required.

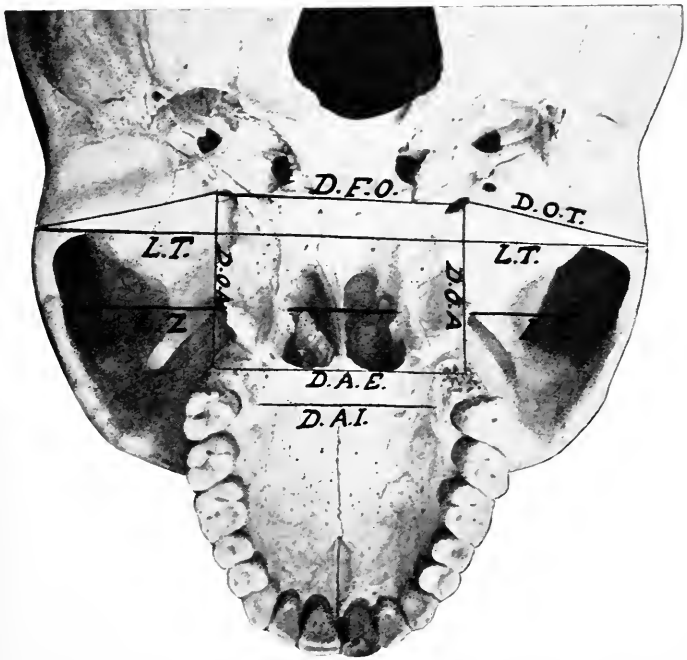

FIG. 123.—To show measurements to be taken for locating foramen ovale and foramen rotundum. Explanation in text. (Offerhaus.)

Offerhaus[3] gives the following measurements of sixty skulls to perfect the landmarks for the location of the foramen rotundum and the foramen ovale, upon which he bases the rules for his improved method of locating foramina for deep indications of the trifacial nerve:

"(1) The distance between the foramina ovale (*D. F. O.* on Fig. 123) equals that between the alveolar processes of the upper jaw, measured

[1] Glasgow Med. Jour., August, 1915, p. 98. [2] Lancet-Clinic, April 24, 1915.
[3] Practical Medicine Series, 1910, x, 149; after Arch. f. klin. Chir., 1910, xcii, 47.

in the mouth between their outer borders behind the last molars at the tuberosities (pyramidal processes) of the palate bone (*D. A. E.*, Fig. 123). (2) On making frontal sections through the skull just in front of the tuberosities (tuber maxillare), the foramina ovale are seen either in the section or, more frequently, 1 to 6 mm. posteriorly, and 3 or 4 mm. above a line (linea intertubercularis, *L. T.*, Fig. 123) uniting the inferior borders of these tuberosities. (3) The distance between the foramina rotunda equals the distance between the alveolar processes of the upper jaw, measured internally, behind or at the last molar (*D. A. I.*, Fig. 123). (4) The foramina rotunda lead to the upper and posterior part of the sphenopalatine fossa, while the sphenopalatine foramina are on the mesial side. A line (linea interzygomatica, *L. Z.*, Fig. 123) uniting the latter crosses the upper border of the zygoma at its middle or at the junction of its temporal and malar portions. The foramina rotunda lie 2 to 4 mm. above and slightly behind this line. (5) The distances from the foramen ovale to the outer border of the tuberosity (tuberculum articulare) (*D. O. T.*, Fig. 123), and from the foramen rotundum to the outer border of the zygoma, are equal on the right and left sides except in the few very asymmetrical skulls.

"*In vivo*, in order to determine the depth of the foramen ovale it suffices to measure the distantia interalveolaris externa (*D. A. E.*) and the distantia intertubercularis (*L. T.*). If the former, for example, is 5 cm. and the latter 14 cm., then the foramen ovale is at a depth of $\frac{14-5}{2}$ = 4.5 cm. The same is true of the second branch of the trigeminus and the foramen rotundum, mutatis mutandis. In the living, however, it is not easy to determine the exact direction of the linea intertubercularis and interzygomatica, so I have constructed a caliper with movable rods at the ends (Fig. 124). The caliper is placed on the tubercula articularia, which are readily felt through the skin, and the distance measured; then the caliper is removed, placed at the same width, the rods are placed in line, and the instrument put back on the tubercula, when the rods indicate the proper direction in which to introduce the needle (Fig. 125)."

The author also gives rules for directing a curved needle from the mouth through the foramen ovale in such a way that the Gasserian ganglion itself may be injected (Fig. 126).

The Härtel method of injecting the Gasserian ganglion is the one now more generally adopted. The left index finger is placed between the jaw and cheek with the patient's mouth closed. The space between the coronoid process of the mandible and the maxillary tubercle is located. The cannula is introduced into the cheek at a point opposite the second molar. With the finger inside the mouth as a guide, the cannula is forced subcutaneously between the mandible and the maxillary tubercle, directly upward until the hard smooth surface of the sphenoid bone is felt. Härtel calls particular attention to the necessity for

proper alignment of the cannula at this point in the procedure, so that a line drawn vertically upward from the point of entrance of the needle into the skin will bisect the pupil of the eye when looked at from the front, but if looked at from the side it will bisect the articular eminence of the zygoma (see Fig. 127). The cannula is now pushed backward and slightly upward until the guard on the cannula which has been fixed at 6 cm. indicates that this depth has been reached. Slight movement of the point of the cannula over the smooth surface of the bone gives indication, when the resistance is no longer felt, that the point has penetrated into the skull through the foramen ovale.

FIG. 124.—Instrument used for determining direction of needle. (Offerhaus.)

Approximately 2 c.c. of 80 per cent. alcohol is injected into the ganglion, a few drops at a time. Dorrance advocates moving the point of the syringe from side to side in order to come in contact with as much of the ganglion as possible.

The after-treatment consists in covering the point of the puncture of the skin surface with collodion dressing. The eyes need protection and care following the alcohol injection of the Gasserian ganglion, the same as after the ganglion operation. They should be flushed with boric acid solution and protected with watch-glass crystals, suitably arranged with cotton or felt rings. Close observation and care of the

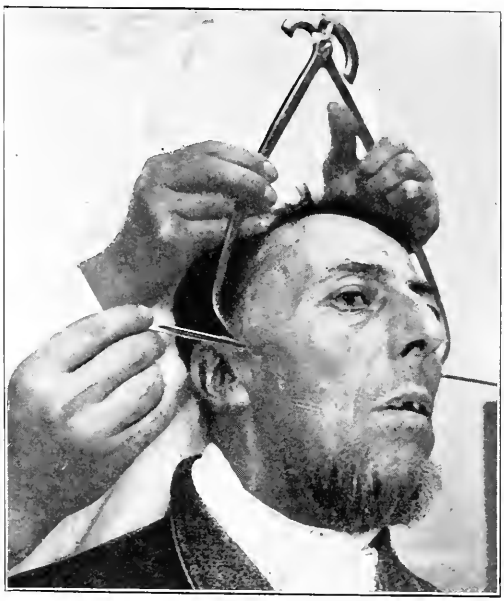

FIG. 125.—Instrument *in situ* preparatory to injection of inferior maxillary nerve at foramen ovale. (Offerhaus.)

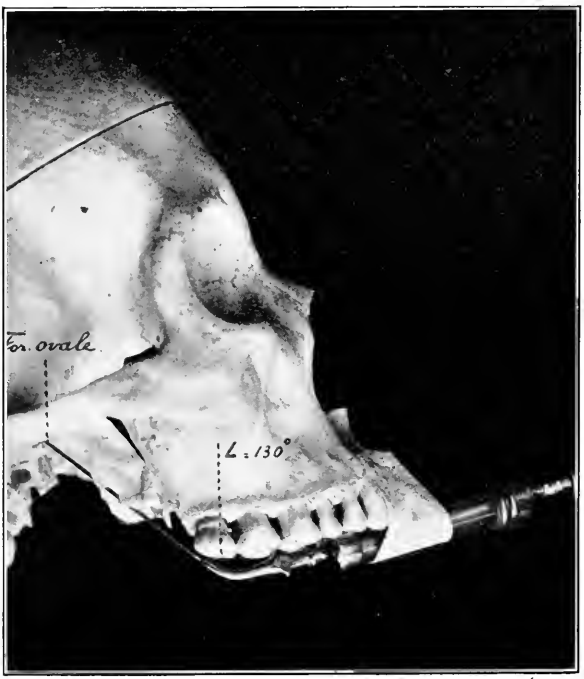

FIG. 126.—Method of reaching Gasserian ganglion through foramen ovale. (Offerhaus.)

eyes should be given for eight to ten days after the injection. The chief danger appears to be loss of vision of the eye on the affected side.

But there is also danger of a puncture of the internal maxillary artery, of injection into the Eustachian tube, of coming in contact with a rough bone surface and therefore being below the foramen. Complications of the oculomotor nerve, facial nerve, and the soft palate, herpes facialis, keratitis, corneal ulcer, and paralysis of the sixth nerve have been reported by Härtel and others.

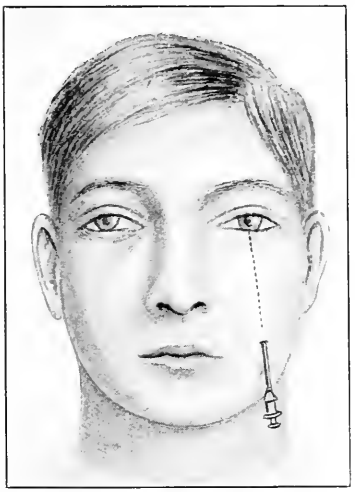

FIG. 127.—Illustration of the point of entrance through the cheek and the direction of the cannula for alcoholic injection of the Gasserian ganglion. Härtel's line to bisect the pupil of the eye when looked at from the front is marked as recommended by Dorrance.

A few deaths from ulcer have been reported and in most of these cases there appears to have been some other complication. There seems to be freedom from these objections with improved technic, and it is not unlikely that this may, in the course of time, entirely supplant more serious operative features for the relief of tic douloureux.[1]

The reports of the result of this treatment vary considerably, and but few authors claim that trigeminal neuralgia can be permanently cured in this way. All, however, are agreed that a measure of relief can be given, which may last from a few days to months or even a year or more. Schlösser reports 123 cases with cessation of pain during the average period of ten and two-tenths months. Brissoud,[2] Cicard, and Tanon report 18 cases, with an average relief from three to five months. Patrick urges in its favor that the operation is practically devoid of

[1] Dorrance, Geo., Phila.: "Injection Gasserian Ganglion," Dental Cosmos, January, 1916; Byrnes, C. M., "Alcohol Injection Gasserian Ganglion," Johns Hopkins Hospital Bulletin, January, 1915.

[2] Revue Neurolog., March 30, 1907.

danger, requires no anesthetic, that relief can be given in many cases for a year or more, with but little inconvenience to the patient.

The author's experience, based upon the observation of many patients who have come under his care after having previously had alcohol and osmic acid injections, according to the old methods of peripheral treatment are not favorable. In almost all of these cases the period of relief was hardly sufficient to compensate for the discomfort following the injection, and in some of them even repeated injections had failed to give the desired relief. More modern technic in the deep alcoholic injections of the superior maxillary division at the foramen rotundum, and the inferior maxillary division at the foramen ovale, have been so satisfactory in their results as to make many of the peripheral operations, which the author performed frequently in the past, quite unnecessary.

There is a considerable difference in individual cases in the results of these injections. Occasionally the severe immediate pain is quickly followed by numbness along the line of the distribution of the nerve, and relief from pain. Sometimes this disappears quickly, sensation, and ultimately pain returning. In other cases there seems to be a hard battle between the nerve tissues and the alcohol, and more or less pain continues for some time, after which there may be a long period of relief. Occasionally it is necessary to make a reinjection in a short time, and even then the desired relief may come very slowly. But the difficulties of injection are so slight when compared with any kind of operation, and the suffering of these patients is so great, that this feature of the treatment is comparatively inconsiderable when the more or less continuous torture is considered. The necessity for repeating the injection is after all not a serious matter. The continued injection of alcohol in the close vicinity, or in actual contact with the nerve must almost surely cause degenerative changes which will give ultimate relief of sufficiently enduring character.

SURGICAL METHODS OF TREATMENT IN NEURALGIA.

Neurotomy.—Simple division of the nerve was suggested by Albinus and Galen and first performed by Schlichting in 1748. It is of little value because of rapid regeneration.

Neurectomy.—Excision of a section of a nerve was first performed in 1793 by Abernethy. The piece removed should not be shorter than 1 cm., but even with this method regeneration is not entirely prevented.

Nerve Extraction.—According to the method of Thiersch extensive extirpation of nerves is done by grasping the ends of the nerve with a forceps which is slowly turned a half-turn every second or slower, until as much as possible of the nerve has been removed (Fig. 128).

Nerve Stretching.—This operation was first performed on the trigeminus by Vogt in 1876 but it is not permanently effective.

Other Methods.—Thiersch recommended *the removal of painful scars* with neurotomy or in combination with other operations. *Crushing* and *cauterizing* the *central end* of the divided nerve was done by Klein

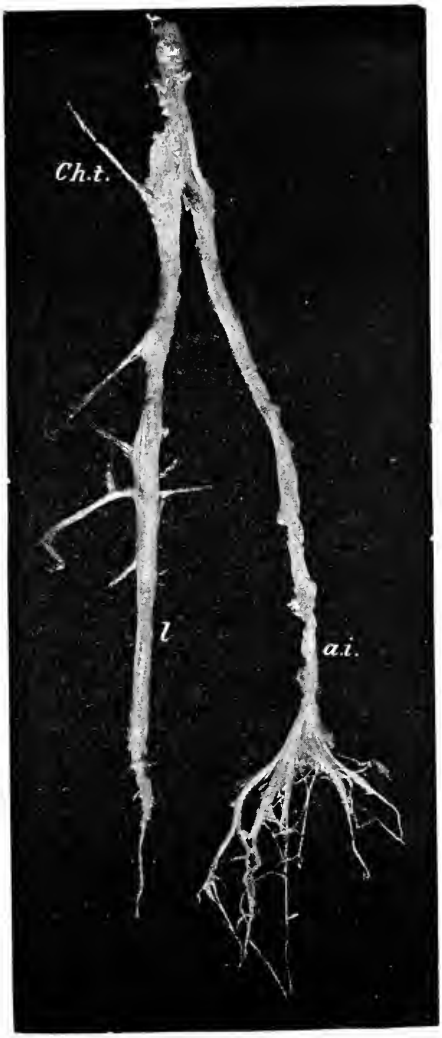

FIG. 128.—Inframaxillary nerve extracted, according to Thiersch, from a man aged forty-three years. *Ch. t.*, chorda tympani; *l.*, lingual nerve; *a. i.*, inferior dental nerve. Five-sixths natural size. (After Bull-Von Bergmann.)

in 1822, and the peripheral end by Boyer. Galvanocautery has been used to divide the nerve. *Splitting one* or *both ends* and *turning them back into a loop* was suggested by Malgaigne. *Plugging of the foramina* to prevent regeneration of the nerve has also been employed.

Operations for Exposure of the First Trigeminal Branch (Ophthalmic Nerve).—The eyebrows are shaved, the skin surface is properly prepared, and an incision following the outline of the eyebrow is made of sufficient length to give freedom in exposure of the nerve. The tissues are divided down to the supra-orbital notch through which the nerve passes. The nerve is grasped with a forceps, separated from the surrounding orbital fat, which may be facilitated by care to avoid laceration in separating the periosteum. The nerve is then drawn out until the supratrochlear nerve is brought into view. The nerve is divided behind this branch and a sufficient amount of the peripheral portion of the nerve is removed. It is possible to reach the lacrimal nerve where it leaves the ophthalmic far back in the cavity of the orbit, and the ethmoid nerve at its point of entrance into the anterior eth-

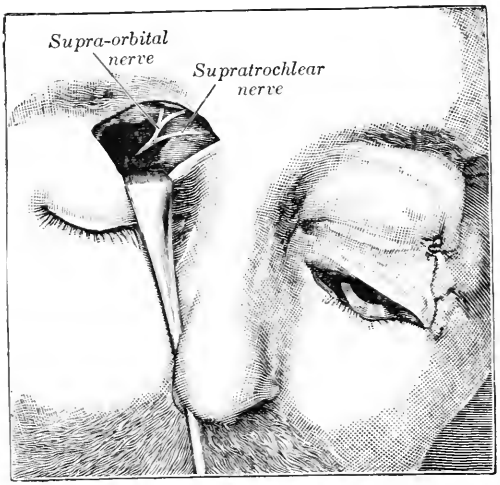

FIG. 129.—Exposure of the supra-orbital and supratrochlear nerve at the right eye. Incision to expose the infra-orbital nerve at the left eye. Two-thirds natural size.

moidal foramen at the inner and upper aspect of the orbit. The comparative unimportance of these branches, however, when weighed against the possibility of serious affections of the eye following disturbance of the contents of the orbit makes it doubtful whether search for these smaller, more deeply seated branches is warranted except under rare conditions. Krause states that he has seen very severe iritis develop after extraction of the supra-orbital nerve which left behind a spot on the cornea (Fig. 129).

Operation upon the Second or Infra-orbital Division of the Fifth (Figs. 130 and 131).—The approach of the infra-orbital foramen through which this nerve passes may be accomplished in two ways. The one is through an external incision begun about 0.5 cm. beneath the mesial end of the infra-orbital margin and extended obliquely downward and outward to the lower border of the malar bone. Sometimes a circular

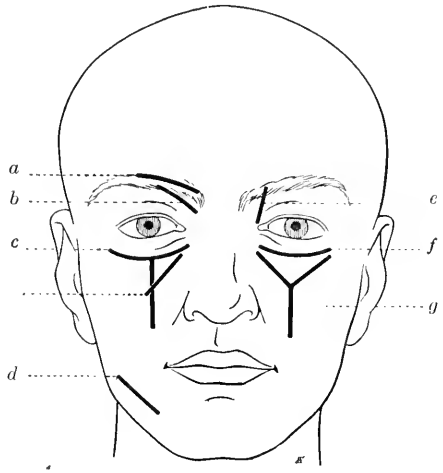

FIG. 130.—Various incisions for reaching different branches of the trifacial nerve: *a*, supra-orbital; *b*, external nasal; *c*, Bruns' incision; *d*, inf. dent. at mental foramen; *e*, internal nasal; *f*, infra-orbital; *g*, Carnochan's incision. (Marion.)

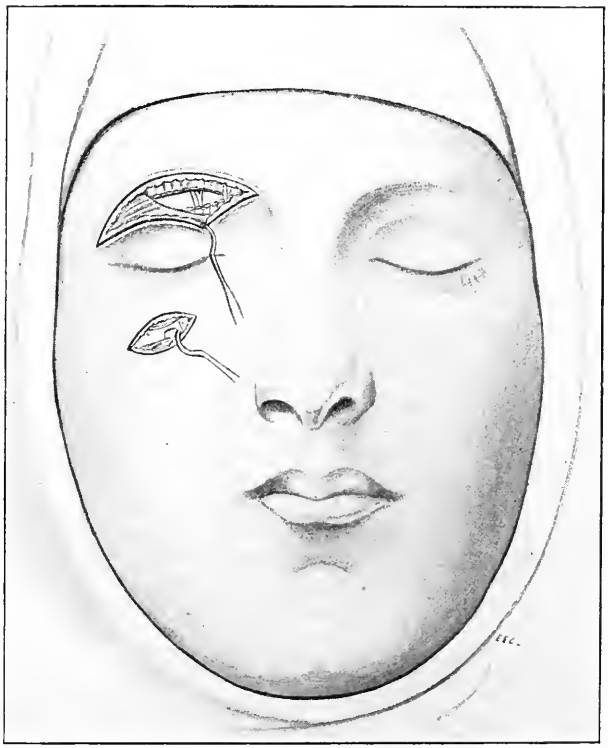

FIG. 131.—Exposure of the supra-orbital and infra-orbital branches of the fifth nerve.

incision following the outline of the orbit is used, and for more extensive dissections a T-shaped incision is used, the perpendicular portion extending from the infra-orbital to a point near the angle of the mouth. On account of the unsightly scar the larger incisions are to be avoided if possible. When the nerve is exposed at the infra-orbital foramen it may be raised with a hook or grasped in a forceps, a portion is resected, and the infra-orbital canal is plugged with a screw, as recommended by Mayo, or else by a metal plug such as the silver buttons used by Moschcowitz[1] and illustrated in Fig. 132, or a plug of metal, wax or other non-irritating substance. Otherwise the more extensive operations as described by Krause[2] may be performed.

Fig. 132. — Silver buttons used by Moschcowitz to plug the infra-orbital foramen in treatment of trigeminal neuralgia.

"The length of the incision is 4 cm. At first the incision is carried only through skin and fasciæ down to the levator labii superioris (musculus quadratus labii superioris), care being taken to avoid the branches of the facial nerve. The fibers of the muscle run downward and across the incision. The upper branches of the infra-orbital nerve (palpebral and nasal) appear in the incision, since they run upward to the upper edge of the wound. They are to be spared. Search is then made for the infra-orbital foramen; it lies in the uppermost part of the canine fossa, as a rule 1 cm. beneath the bony infra-orbital margin and generally somewhat on the inner side of its center. Over it the origin of the levator labii superioris and the periosteum are divided down to the bone transversely, and the periosteum then reflected downward with a raspatory until the infra-orbital plexus is completely exposed. The latter is dissected free from the infra-orbital artery, freed bluntly for a distance from the surrounding fatty tissue, and grasped with a clamp. Now the periosteum of the orbital margin and of the floor of the orbit is reflected as far as possible into the latter. If the entire contents of the orbit are carefully raised with a broad hook the nerve can almost always be seen shining through the thin upper wall of the canal as a white streak as soon as the hemorrhage, which is always slight, has ceased. Farther backward it is often seen lying free in the sulcus. The canal runs a rather straight course from behind forward; its bony walls are thin, except in its most anterior portion, where for the distance of about 0.5 cm. the upper wall is formed by the broad infra-orbital margin. Here a wedge-shaped piece of bone is removed with a small chisel; farther backward the protecting layer of bone can generally be broken off with anatomical

[1] Alexis von Moschcowitz: Med. Record, September 29, 1906; Practical Medicine Series, 1907.

[2] Bull and von Bergmann: System of Practical Surgery, vol. i, p. 574.

forceps. In this way all the structures filling the infra-orbital canal are laid bare up to the sphenomaxillary fissures, and are then bluntly lifted out of the bony furrow. They consist of the infra-orbital nerve, artery, and veins; the artery accompanying the nerve lies on its inner and under side."

The author believes that external openings for operation upon this branch of the nerve are unnecessary and to be avoided because of the unsightly scars. The class of cases in which peripheral operation upon this division of the nerve is successful is usually quite as much benefited without the danger and difficulty of following the nerve into the deeper portions of the bone, because cases of central origin or those in which the disease has progressed beyond the limits of more external peripheral limitations are usually such as require operations upon the ganglion, or at least extracranial operations at the base of the skull or deep injections. While it is admitted that this might not always be true, the objection to disturbances of the orbital contents is one that on general principles should require careful consideration and absolute certainty of its necessity before being undertaken.

Buccal Incision for Exposure of the Nerve at the Infra-orbital Foramen.—External scar and consequent disfigurement may be avoided by an incision through the mucous membrane and periosteum carried down to the bone in the region of the canine fossa, the periosteal and overlying tissues being separated from the bone with a periosteotome. The bone surface is followed up to the infra-orbital foramen, which should be found in direct line above the interproximate space of the bicuspid teeth. Variations through irregularities of the teeth or upper jaw, however, render such guiding lines uncertain. In the author's experience it has been found safer and more satisfactory after having separated a sufficient periosteal surface to insert the first finger and to continue the periosteal separation by pressure in this way. The same finger of the other hand serves as guide, and is placed over the foramen, which can usually be felt from the external surface until the nerves and vessels as they pass through the foramen can be followed with the tip of the finger inserted into the wound from within the mouth. With the finger in this position, as shown in Fig. 133, a hook can then be inserted and guided into place, the nerves and vessels caught and sufficiently withdrawn to make it possible to grasp them more firmly in a forceps. By making tension, a sufficient portion of the nerve can readily be resected at this point. Instead of resorting to the use of screws or metal plugs a very simple and satisfactory procedure is the author's modification of this operation as usually performed. It has proved to be exceedingly satisfactory to obliterate the canal by enlarging the external opening with a bur in a dental engine, following the nerve as far in its bony canal as may be safely done without risking injury to the contents of the orbit, and by freshening bony surfaces with the bur, to insure new bone growth, which will completely fill and block the external opening, thus preventing the

likelihood of nerve regeneration. When it is found necessary to follow the nerve back to the sphenomaxillary fossa, in cases where the internal opening is made, this is best done by opening into the maxillary sinus. Objection to this is made by some authors on the ground that there is more likely to be infection when the maxillary sinus is opened. Therefore the external opening is to be preferred. This, according to the author's experience, is an erroneous view, because in large numbers of patients suffering from tic douloureux he has found that the maxillary antra were enlarged and either diseased or a continued menace in offering the likelihood of irritation in that region. Therefore entirely outside of the question of neurectomy it is frequently a safeguard to have the maxillary sinus properly opened and its condition

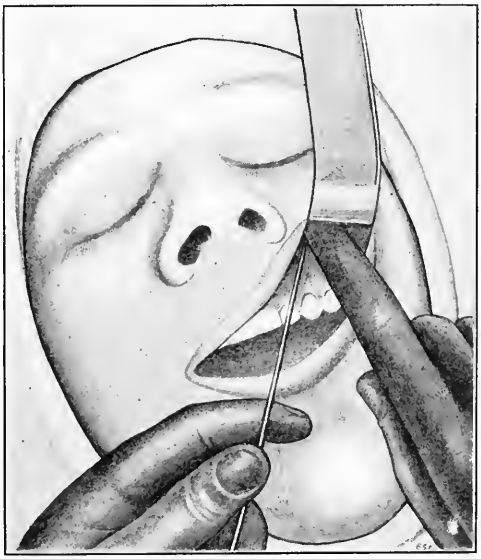

FIG. 133.—Resection of the second division of the fifth nerve at the infra-orbital foramen through an intrabuccal incision.

definitely ascertained. Whenever there is the slighest suspicion of maxillary sinus trouble he believes that the proper method is to open through the external wall of the sinus, selecting a point in the region of the canine fossa at which the wall may be found to be most yielding, and extending this opening until the entire external wall of the maxillary antrum has been removed. In enlarged sinuses, such as those usually found in these cases, an opening of this kind will, in most cases, be large enough to admit the insertion of a finger, and when hemorrhage has been checked permit a good view of the floor of the orbit. The distance from the upper border of the external opening to the foramen is usually very slight, and therefore exposure of the nerves at this point is easily accomplished. Frequently the nerve is found

to be almost completely exposed when the mucoperiosteal lining of the antrum has been removed. These are the cases in which the portion of the nerve posterior to the infra-orbital canal is likely to suffer continued irritation after resection at the infra-orbital foramen. They are also the ones in which the nerve may be most easily followed back in the direction of the sphenomaxillary fossa. To those who are accustomed to treat the maxillary sinus by radical operation, this procedure will not be a matter of serious consideration. The danger of infection with proper care is not significant. The ultimate closure of the opening without external deformity is assured, and the danger of future disease and irritation reduced to the minimum. Results in the author's cases have been exceedingly satisfactory.

Carnochan reaches the nerve at the foramen rotundum through the maxillary sinus by a large external incision which joins the incision made near the lower orbital border at the infra-orbital margin, and is extended down the cheek close to the nose. A flap is reflected downward and upward and the maxillary sinus opened just below the infra-orbital foramen. He follows the nerve back, trephines the posterior antral wall to expose the sphenomaxillary fossa, and through this continues backward to the foramen rotundum, where the nerve is twisted and cut with curved scissors. This appears to be unnecessarily severe in view of the fact that removal of the Gasserian ganglion may after all be necessary and no kind of peripheral operation sufficient.

Third or Inferior Maxillary Division of the Fifth Nerve.—The mental branch can be readily exposed at the mental foramen, the foramen enlarged with a surgical or dental engine bur, and the inferior dental canal exposed as much as may be necessary to give opportunity for resection of a sufficiently large portion of the nerve. Cryer has called attention to the fact that the direction of the nerve at its exit through the mental foramen is slightly backward, so that it is usually impossible to enter the inferior dental canal with a probe passed through the mental foramen in a backward direction. It is therefore necessary to enlarge the foramen and extend the opening backward along the line of the canal until a sufficiently clear entrance has been effected. The nerve may be grasped, drawn forward, and a section evulsed according to the Thiersch method, or a long flexible dental engine drill, especially made for the purpose, can be passed into the canal, and its nerve and vessel contents cut out for a considerable distance. Sometimes this can be done almost completely to the angle of the jaw (Fig. 134).

The author formerly used to fill the inferior dental canal after the removal of the nerve with a gutta-percha point which had been softened in a solution of gutta-percha and chloroform, and was forced into the canal after controlling hemorrhage and flooding the canal with oil of eucalyptus. Such a gutta-percha plug was found to offer no resistance to healing processes which took place upon the mucous membrane surface quite promptly, and covered the gutta-percha at the foramen completely. But in the course of time the gutta-percha was

eventually thrown out. During recent years he has adopted a modification of Garretson's operation, and instead of endeavoring to remove a section of the nerve through an enlarged opening at the mental foramen and filling as described, he has carried the bur back from one to two inches and removed the external wall of the canal. This portion of the nerve is of course entirely destroyed and the inferior dental canal practically eliminated as the result of a complete obstruction of the canal by new growth of bone and connective tissue. If the source of irrita-

FIG. 134.—Third or inferior maxillary division of the fifth nerve exposed at the mental foramen and the inferior dental canal opened for resection.

tion happens to be in the anterior portion of the lower jaw this operation will be effective. But if situated farther back the result will naturally be unsatisfactory. In some cases it is therefore necessary to reach this division of the nerve at its more central portion.

The nerve may be reached by perforating the jaw at any point along the line of the inferior dental canal. Cryer has suggested entrance through the ramus of the jaw by deepening the sigmoid notch until the nerve is reached at its entrance to the mandibular foramen. To accomplish this and to avoid scarring, the incision is carried down

along the posterior border of the jaw, the periosteum separated from the bone with the overlying muscular attachment of the masseter, and retracted until the external surface of the ramus is exposed. The nerve may be divided by an incision within the mouth, carried through down to the inferior side of the anterior border of the ramus, separating the pterygoid muscles and periosteum, which are forced away with the periosteotome and finger until the mandibular foramen can be felt. The difficulty, however, in attempting this operation is that it does not give the best opportunity for resection of a sufficient portion of the nerve. In the recent case of a patient in whom the vessels of the mandibular foramen were severed, severe hemorrhage followed, with tendency to recur whenever the packing was removed. This has con-

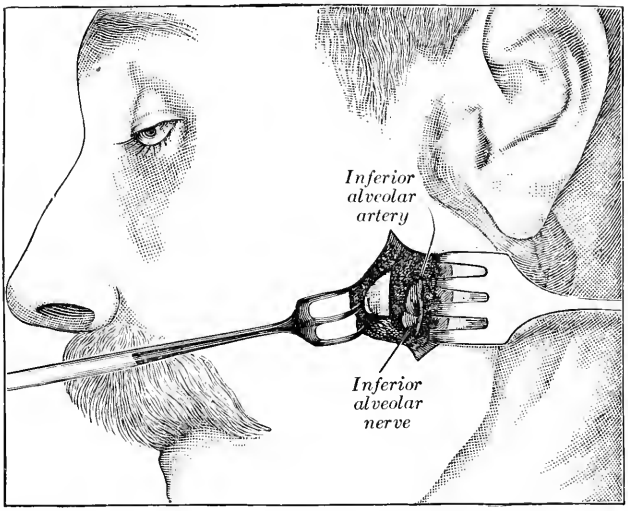

FIG. 135.—Relation of the inferior dental artery to the inferior dental nerve in the canal in the lower jaw, chiselled open for operation. Three-quarters natural size.

vinced the author that whenever an operation is performed which is likely to involve the inferior maxillary artery accidentally or otherwise, the method of approach should be such as to offer opportunity for direct control of the vessel. A number of authors advocate trephining the jaw at a point midway between the anterior and posterior border of the ramus just above the angle of the jaw. To do this an incision is made, as recommended by Krause, directly through the skin, masseteric fascia, masseter muscle, and periosteum to the bone. The incision may also be carried around the lower border of the jaw, around the angle of the jaw, dividing the skin and superficial fascia, isolating the two upper branches of the facial nerve and Stenson's duct. After retraction, the incision is carried through the masseter muscle down to the ascending ramus of the jaw which is trephined just above the angle.

The nerve is grasped with forceps and followed upward for an inch and divided. By either incision the facial nerve has to be avoided and scarring upon the external surface of the cheek prevented. The lingual nerve may be found directly under the mucous membrane of the tongue in the region of the three last molar teeth, just after it has entered the base of the tongue between the ramus of the lower jaw and the palatoglossal arch. The mouth is opened with a suitable gag, the tongue pulled to the healthy side and upward, the mucous membrane divided at a point just anterior to the lower molar tooth, and the incision carried from before backward with care to avoid the tongue. With the nerve thus exposed a portion can be extracted and the wound sutured (Fig. 135).

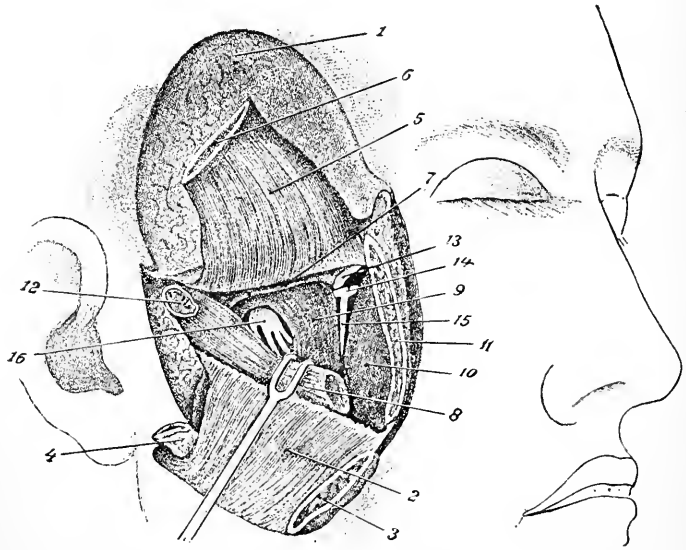

FIG. 136.—Exposure of the second and third branch of the trigeminal nerve close to the foramen rotundum and foramen ovale (Krönlein's temporal method): *1*, turned-up skin flap; *2*, turned-down flap of zygoma and masseter; *3*, anterior sawed surface of the zygoma; *4*, posterior sawed surface of the zygoma; *5*, turned-up flap of coronoid process and temporal muscles; *6*, cut surface of the coronoid process; *7*, infratemporal crest; *8*, external pterygoid muscles; *9*, pterygoid process; *10*, maxillary tuberosity; *11*, sawed surface upon the upper jaw; *12*, sawed surface upon the zygomatic process of the temporal bone; *13*, spinous tubercle; *14*, superior maxillary nerve; *15*, palatine nerve; *16*, inferior maxillary nerve at the foramen ovale.

Extracranial Operations at the Base of the Skull.—The number of these operations represent almost unlimited modifications of Lucke's original method, which included osteoplastic resection of the malar bone and an opening through the sphenomaxillary fossa to the foramen rotundum. Entrance through the antrum of Highmore has already been described. The incision through the cheek from a point close to the angle of the mouth to the lobule of the ear is carried down to the buccinator muscle, but cautiously so as not to divide the mucous

membrane of the mouth, the fibers of the facial nerve, the parotid gland, and Stenson's duct are avoided, the intervening bone and muscle structures are removed, and the lingual and inferior dental branches located and traced back to the foramen ovale. Mikulicz makes an incision from the mastoid process at the anterior edge of the sternomastoid down to the hyoid bone and upward and forward in a curve to the margin of the lower jaw at the anterior border of the masseter muscle. At this point the incision is carried down to the bone of the lower jaw, which is divided behind the third molar tooth, the ramus is turned upward and the body of the jaw pulled forward, and the divided dental and lingual nerves are found located upon the internal pterygoid muscle which has been separated from its attachment. Of all the operations suggested, the most important seems to be Krönlein's temporal method for exposure of the second and third branches of the trigeminal nerve close to the foramen rotundum and foramen ovale (Fig. 136).

Removal of Gasserian Ganglion.—Operation for the removal of the Gasserian ganglion should be resorted to under the following conditions:

1. When all efforts to check the pain by medical treatment and the correction of sources of peripheral irritation have failed.
2. When peripheral operations have been unsuccessfully tried for the relief of pain, apparently confined to individual branches.
3. When all the branches of the nerve are involved.
4. In almost every case it should supplant operations for division at the base of the skull. When the gravity of operations like those described for reaching the foramen ovale and the foramen rotundum is considered, the greater certainty of success and the increasing freedom from danger and ill effect that improved technic has brought about in removal of the ganglion should unquestionably make this the operation of choice.

In 1884 J. Ewing Mears, of Philadelphia, first recommended the removal of the Gasserian ganglion for relief of major neuralgia. Professor Rose, of King's College, London, first performed the operation in 1890. His method of approach was by trephining the base of the skull beneath the ganglion and removing it with a curette. Dr. Edmund Andrews, of Chicago, was the first to perform this operation in America. Cushing[1] has perfected what he calls the transzygomatic route, and has published the sketch shown in Fig. 137, which at once illustrates and describes the methods of approach. Many modifications of the older methods have been suggested by Keen, Frazier, Spiller, Doyen, Poirier, Coelho, and other surgeons. Since the operations most often performed by American surgeons, and therefore the ones upon which most of our evidence of success depends, are the Hartley-Krause and the Cushing, it seems necessary to describe only these two.

[1] Jour. Am. Med. Assn., April 28, 1900.

Victor Horsley[1] resected the second and third division with a high temporal opening in 1900. The operation known as the Hartley-Krause operation was devised by Krause, and first performed by Horsley August 8, 1891, and by Krause February 23, 1892. In neither of these operations was the ganglion removed. Only the second and third divisions were divided. January 31, 1893, Krause removed the ganglion by this operation.[2]

Krause calls attention to the necessity of washing out the eye with boric acid solution before the operation, and to the need of the protection of the eye. This he accomplishes by the use of a large unground watch-glass held in position with a zinc-oxide adhesive plaster.

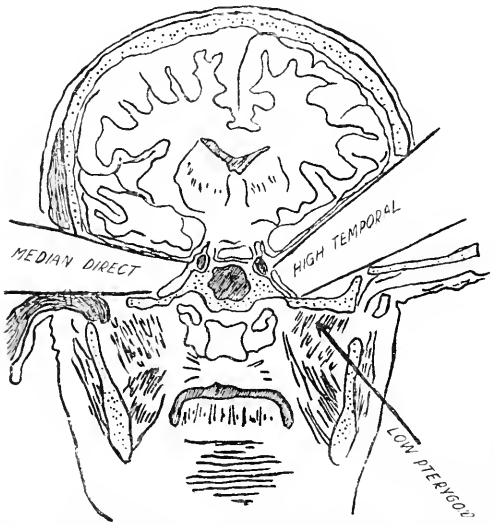

FIG. 137.—Cushing's illustration of transzygomatic route in removal of the Gasserian ganglion. Sketch from a coronal section of the head, schematizing the three chief methods of approach: Oblique methods: (1) The high temporal root (Horsley and Hartley-Krause); (2) the low or pterygomaxillary (Rose, Andrews, etc.). (3) Horizontal direct method transzygomatic (Lexer, Cushing, etc.). The Doyen method demands the space included by all three. (Jour. Am. Med. Assn., April 28, 1900.)

Under chloroform anesthesia the incision is begun just anterior to the tragus. It is "uterus-shaped," first extending upward, then forward, and then downward with base of flap and zygoma. The base of the zygoma is 3 or 3.5 cm. wide, and the height in the center is 6.5 cm. The greatest width is 5 or 5.5 cm. This incision is through all of the tissues down to the base, and is then carried through the bone by means of a circular saw. Sometimes the bone is removed, but is usually preserved, attached to its periosteum, forming the Wagner flap. In the second step the dura is separated from the floor of the

[1] Practitioner, September, 1903.
[2] Jour. Am. Med. Assn., October 11, 1902, p. 900.

fossa to the foramen spinosum, and the brain retracted upward only as far as is absolutely necessary. The middle meningeal artery is always ligated, usually with two ligatures, and cut between them. In the third step the hemorrhage is stopped by packing gauze between the bone and the retractor, holding the brain upward. After the hemorrhage is stopped and the retractor is in position, work with the elevator is begun. The third division is first found and exposed, and then the second. The dura is pushed back from these two nerves and from the ganglion, and the three structures are lifted successfully from the base (Fig. 138).

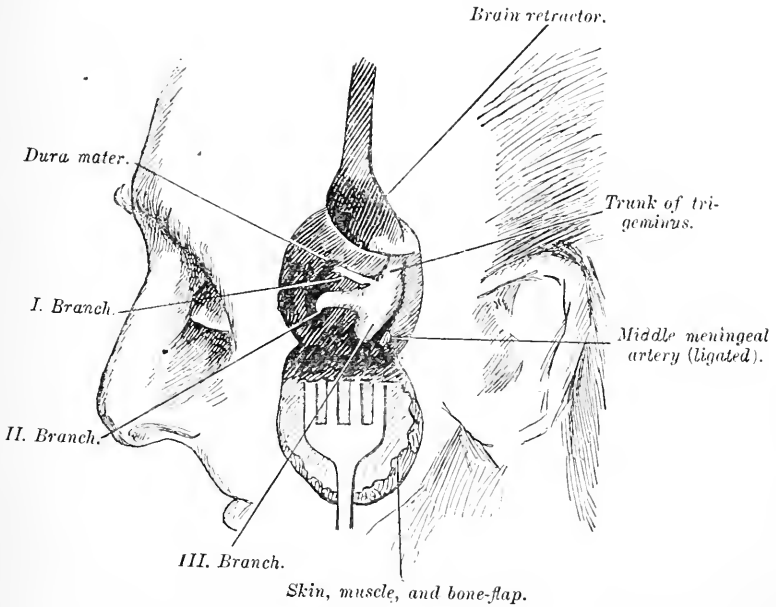

FIG. 138.—Field of operation to remove the Gasserian ganglion, according to Krause.

In separating the dura from the upper surface of the ganglion it may be opened, but this is usually of no importance. The third division is grasped with Pean forceps and lifted upward. The first division is not exposed at any time during the operation, except at its junction with the ganglion, because of its position in the wall of the cavernous sinus and its proximity to the third, fifth, and sixth nerves.

After isolation of the ganglion it is grasped with forceps at its junction with the sensory root; the second and third divisions are cut off at their exit from the foramina, and the sensory root is twisted out by means of the attached forceps. It is sometimes taken off at the pons. The first division usually tears off close to the ganglion. The ends of the nerves are pushed down into their foramina; the retractor is removed and the flap brought into position. So far the motor root

has not been separated from the ganglion in the performance of the operation, but experiments have shown that it may be possible to do it.

Cushing's operation, as shown in his illustration (Fig. 137), is somewhat lower than the Hartley-Krause. The U-shaped incision, with its base directed downward, is made between the eye and the ear, with its upper part slightly above the center of the zygoma, the lower points a little below. The zygoma is divided at each end and turned down with the flap. The incision is carried through the temporal muscle to the temporal bone, which is separated from its attachments, including the periosteum, in such a manner as to expose the lower portion of the temporal fossa down to the attachment of the external pterygoid muscle below the temporal crest. An opening is then made with a tre-

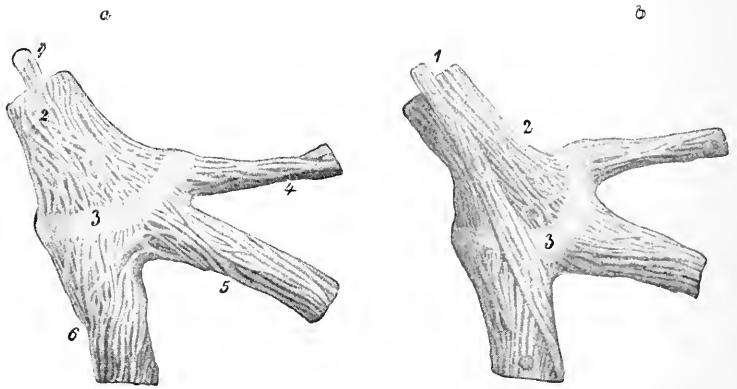

FIG. 139.—Gasserian ganglion, with its roots enlarged; *a*, external view; *1*, small motor root; *2*, large sensory root; *3*, semilunar ganglion, over which the motor root passes to get to the third branch; *4*, first branch; *5*, second branch; *6*, third branch. (After Rüdinger, Bull-von Bergmann.)

phine and enlarged until it is about 3 cm. in diameter. The middle meningeal artery is avoided by continuing the operation in a slightly anterior direction. The dura is elevated to expose the foramen ovale and its elevation continued until the foramen rotundum is reached. Division of the commissure of the under layer of the dura admits of its being gently raised from the ganglion back to the sensory root. The ganglion is then elevated, freed from its attachment to the dura, and the first branch of the nerve is separated with care to avoid the cavernous sinus. The three peripheral branches are then elevated with blunt hooks and sutured close to the foramen, the ganglion grasped with forceps and evulsed. The parts are replaced, and held in position with suture without drainage (Fig. 139).

The effect of the removal of the Gasserian ganglion as evidenced by altered sensation is shown by Figs. 140 to 143.

Mortality.—In 100 cases collected by Tiffany[1] the mortality rate was 22 per cent.; in a second series of 100 cases reported by Carson[2] the mortality was 11 per cent. Most of these operations were according to the Hartley-Krause method. Murphy and Neff's report of 42 cases with 6 deaths, which is here given because of its valuable record

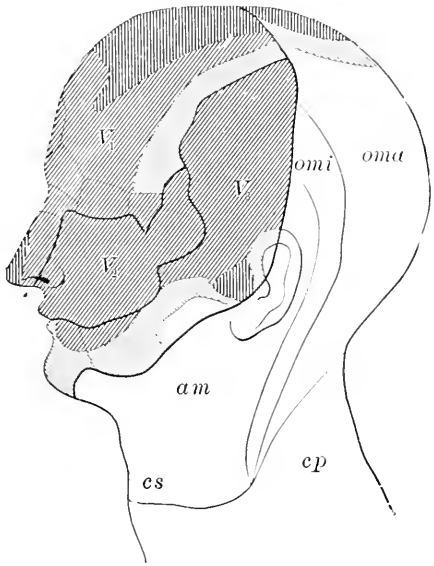

FIG. 140.—Scheme showing effects of total extirpation of Gasserian ganglion forty-seven days after operation. Sensation of heat spoken of as slightly warm; sensation of cold absent. V_1, V_2, V_3, first, second, and third branches of fifth nerve; *oma*, occipitalis major; *omi*, occipitalis minor; *am*, auricularis magnus; *cs*, subcutaneous coll (Friedrich.)

Zone of absolute anæsthesia and analgesia; complete loss of temperature area

Zone of nearly complete anæsthesia and analgesia.

Zone of distinct but diminished hypalgesia and hyperæsthesia.

Area of normal sensation

Outline of innervation zones of trigeminal.

of other operative aspects as well as mortality, shows about 15 per cent. Cushing reports 20 cases of his own operated upon according to his own method, with a mortality of 5 per cent. The steadily improving mortality rate under improved operations and technic is encouraging.

[1] Annals of Surgery, 1896, xxiv, 575.
[2] Med. Review, St. Louis, 1899, xxxix, 199.

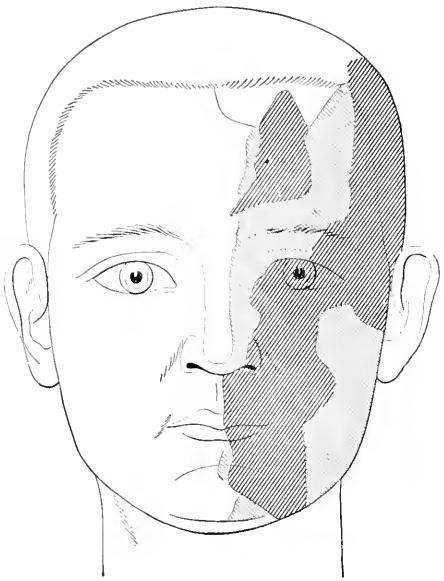

FIG. 141

Zone of absolute anesthesia and analgesia. Sixty-three days later than in Fig. 140. (After Bull-von Bergmann.)

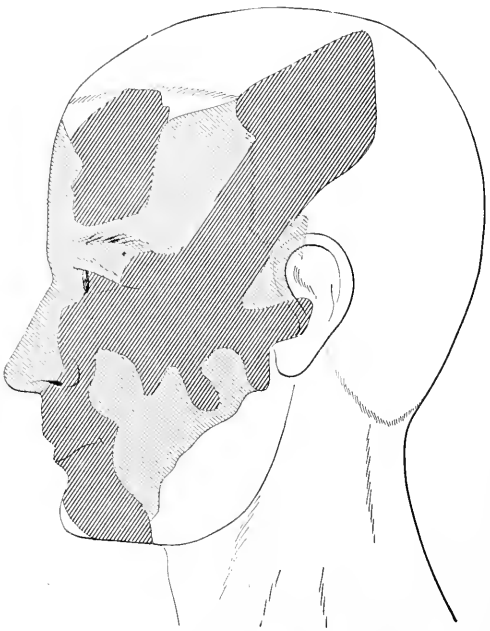

FIG. 142

Zone of hypalgesia and hyperesthesia. Sixty-three days later than in Fig. 141. (After Bull-von Bergmann.)

The records of 42 cases gathered by Murphy and Neff (see pages 276 to 279 are given in detail because these cases appear to show the best possible data upon which to base judgments of many features of operative results as well as the question of mortality.

Later reports by Cushing of over 100 cases with almost no mortality, and the results obtained by Frazer and many other operators who have followed the improved methods of these two operators, have reduced the question of mortality almost to a negligible factor. Nevertheless, the ease and safety of alcoholic injections still warrant the employment of this treatment before the more radical Gasserian operations are resorted to. It is even possible that alcoholic injections of the Gasserian ganglion may be found to be entirely sufficient.

FIG. 143.—Photograph taken on the tenth day after operation. (Cushing.)

THE DENTAL ASPECT OF TRIGEMINAL NEURALGIA.

The dental and oral aspect of trigeminal neuralgia is generally conceded to be a matter of great importance. Many vital features, however, are but little appreciated, and there is much confusion in the views of dentists, oral and general surgeons, and practitioners of other divisions of medicine in regard to the importance and the character of the effect of local influences in the region of the mouth. In the description of real or fancied effects from treatment or removal of teeth, dentists have made exaggerated and often unscientific claims and have done much to destroy the confidence, particularly of those who believe in the more or less definite pathological principles which govern all divisions of the body as affected by various forms of disease. On the other hand, only those who are familiar with diseases of the teeth and their treatment could be expected to diagnosticate or fully understand dental irritation. As a result, the importance of the mouth and the effect of its deformities and diseases is both underestimated and overestimated in its relation to the etiology of trigeminal neuralgia.

	Operator and reference.	Date of operation.	Duration of disease. Years.	Sex, age, side.	Previous operations.
1	Bartlett, Willard, Ann. Surg., June, 1901, p. 683	October 10, 1900	17	Female, 60 years, left	All teeth removed 15 years previous; infra-orbital evulsed, 1898.
2	Bartlett, Willard, Ann. of Surg., June, 1901, p. 683	November 27, 1901	Many	Female, 50 years, right	All teeth removed.
3	Beck, Carl (Chicago), personal communication	November, 1897	4	Male, 48 years, left	Third div. resected 2 years ago; second div. 1½ years ago.
4	Ibid.	May, 1899	10	Male, 42 years, left	Fourteen previous operations; all possible methods from neurectomy to removal of bone.
5	Ibid.	October, 1899	½	Male, 60 years, right	Three previous operations: 1, removal of cyst of face; 2, neurectomy of first div.; 3, neurectomy of first and second divisions.
6	Ibid.	December 10, 1900	Several	Male, 68 years, right	Neurectomy of second division, neurectomy of third division.
7	Coelho, S., Revue de Chir., Paris, May 10, 1899	February 28, 1898	6	Female, 40 years, right	Infra-orbital resection in 1894; inferior maxillary in 1895.
8	Cushing, Harvey, Jour. Am. Med. Assn., April 28, 1900	August, 1899	10	Male, 63 years, right	Infra-orbital evulsed in 1896, inferior dental in 1897.
9	Ibid.	December, 1899	12	Male, 55 years, right	Infra-orbital evulsed in 1892.
10	Ibid.	January, 1900	2	Male, 38 years	Infra-orbital and inferior dental evulsed in 1899.
11	Ibid.	January, 1900	7	Female, 60 years, left	Infra-orbital evulsed in 1897 and 1899.
12	Erdmann, J. F., N. Y. Med. Jour., May 6, 1899	August 8, 1898	4	Male, 53 years, left	Supra-orbital, supratrochlear and infra-orbital nerves excised in 1897.
13	Halstead, A. E., personal communication	November 9, 1900	6	Male, 53 years, right	None.
14	Ibid.	March 3, 1901	7	Female, 57 years, left	Inferior maxillary divided 2 years before.
15	Ibid.	May 12, 1901	10	Male, 50 years, left	None.
16	Krause, F., Münch. med. Woch., June 25, 27, February 9, 1901	March 24, 1899	12	Female, 41 years, right	Resection of first and second divisions in 1898.
17	Ibid.	August 26, 1899	10	Male, 63 years, left	Resection of second division twice.
18	Ibid.	November 2, 1899	..	Female, 59 years, right	Second and third divisions resected in 1896.
19	Ibid.	January 23, 1900	8	Female, 44 years, right	Lücke-Braun of 1898; remained during next pregnancy.
20	Ibid.	February 23, 1900	Several	Female, 58 years, left	Second and third divisions operated upon many times.
21	Ibid.	May 7, 1900	4	Female, 30 years, left	Four previous operations; infra-orbital resected.
22	Ibid.	June 13, 1900	17	Male, 46 years, right	Infra-orbital resected in 1888; second division reseated in 1892.
23	Ibid.	August 27, 1900	7	Female, 50 years, left	Infra-orbital, auriculotemporal and inferior dental nerves resected.
24	Ibid.	August 29, 1900	15	Female, 65 years, right	First and second divisions resected in 1898; no relief.
25	Ibid.	March, 1901	8	Female, 60 years, right	Second division resected in 1898; pain recurred.

Method used.	Result.		Remarks.
	Immediate.	Final.	
Cushing	Recovery	Paralysis of 3d, 4th, and 6th nerves, 4 weeks; recovered	Slight corneal ulcer, which soon healed, followed operation.
Cushing	Recovery	Eye palsies as in above; recovery	No corneal ulceration.
Hartley-Krause	Recovery	Recovery	
Hartley-Krause, with removal of bone	Recovery	Recovery	
Ibid.	Death 54 hours after operation	.....	Carcinoma of parotid; operation undertaken to relieve pain without hope of radical cure.
Ibid.	Recovery	Recovery	
Temporal method Hartley-Krause	Recovery	Recovery	
Cushing	Recovery	Recovery	Results learned by personal communication.
Cushing	.....	Recovery	
Cushing	Recovery	Recovery	
Cushing	Recovery	Recovery	
Hartley-Krause	Recovery	Recovery from pain	Eye lost 7 weeks after operation from ulceration.
Cushing, modified by Hartley	Recovery	Recovery	Ankylosis of jaw followed operation.
Ibid.	Recovery	Recovery	
Ibid.	Death 5 days after operation	.....	Developed suppurative meningitis; had chronic nephritis.
Hartley-Krause	Recovery	Recovery; pain in left side later	
Hartley-Krause	Failure	Failure	Pain was not confined to left side before operation; lesion evidently central.
Hartley-Krause	Recovery	Recovery	
Hartley-Krause	Recovery	Recovery	
Hartley-Krause	Death 6 hours after operation: collapse	.....	Had chronic nephritis.
Hartley-Krause	Recovery	Recovery	
Hartley-Krause	Recovery	Recovery	
Hartley-Krause	Recovery	Recovery	
Hartley-Krause	Recovery	Recovery	
Hartley-Krause	Recovery	Death in 21 days: cardiac disease and pneumonia	

	Operation and reference.	Date of operation.	Duration of disease. Years.	Sex, age, side.	Previous operations.
26	Ibid.	June 6, 1901	7	Male, 64 years, left	Infra-orbital resected in 1894; pain recurred.
27	Ibid.	June 17, 1901	25	Male, 63 years, left	Second division resected in 1893; third division in 1895.
28	Keen, W. W., Jour. Am. Med. Assn., April 28, 1900	Two operations November 9, 1899	½	Male, 32 years, left	Infra-orbital removed in November, 1899.
29	Levings, A. H., personal communication	October 24, 1900	9	Female, 41 years, right	Infra-orbital nerve removed in 1898.
30	Mammen, E., personal communication	November 20, 1894	2	Male, 56 years	
31	Murphy, J. B.	November 5, 1898	9	Male, 59 years, right	Dental operations only.
32	Murphy, J. B.	November 25, 1899	8	Female, 43 years, right	
33	Murphy, J. B.	October 5, 1899	7	Male, 67 years, right	Dental operations only.
34	Murphy, J. B.	October 31, 1899	4½	Female, 51 years, right	
35	Murphy, J. B.	April 15, 1899	2½	Male, 66 years, right	Dental operations only.
36	Murphy, J. B.	May 30, 1900	4	Male, 50 years, left	Second division of fifth resected August 8, 1899; no pain for 8 months.
37	Murphy, J. B.	June 15, 1901	½	Male, 44 years, right	
38	Renton, J. C., Brit. Med. Jour., November 17, 1900	November, 1898	7	Male, 57 years, left	
39	Same as above	August, 1899	5	Female, 67 years, right	Inferior dental excised; pain returned in 3 months.
40	Spellisy, J. M., Ann. of Surg., 1900, vol. xxxi	July 19, 1899	9	Male, 55 years, right	Several teeth removed also infra-orbital and inferior dental nerves in 1895 and 1896.
41	Thomas, J. Lynn, Brit. Med. Jour., October 28, 1899	February 9, 1899	3	Male, 34 years, right	Teeth extracted.
42	Williams, N. T., Phila. Med. Jour., August 10, 1901	September 2, 1899	More than 8	Female, 38 years, right	Nerves divided in 1893; teeth extracted, superior maxillary ganglion removed in 1894; inferior maxillary resected in 1896; intracranial resection of nerves August 30, 1899.

Judging from long years of experience in dealing with the special or at least unusual affections observed in a practice limited to diseases and deformities of the mouth and jaws, and from a wide observation of cases noted in clinics and reported by others, the author has ventured upon the following classification of pathological conditions of the mouth which he hopes may serve to distinguish the affections capable of inducing long-continued painful forms of peripheral irritation, and thus becoming factors of first importance in causing trigeminal pain of neuralgic character, from those that are not, which,

Method used.	Result.		Remarks.
	Immediate.	Final.	
Hartley-Krause	Recovery	Death on 20th day; coma	Grayish patch of softening at base due to pressure from retractor.
Hartley-Krause	Recovery	Recovery	Sclerotic middle meningeal torn.
Hartley-Krause	No improvement	Pain continued	Endothelioma involving the Gasserian ganglion.
Hartley-Krause	Recovery	Recovery	
Hartley-Krause	Recovery	Recovery	Entire ganglion not removed; second division between ganglion and foramen caught by forceps and evulsed; complete relief resulted.
Hartley-Krause	Death; November 13, 1898		
Hartley-Krause	Recovery	Recovery	
Hartley-Krause	Death; meningitis; October 22, 1899		
Hartley-Krause	Recovery	Recovery	
Hartley-Krause	Death; April 17, 1899		
Hartley-Krause	Recovery	Recovery	
Hartley-Krause	Recovery	Recovery	
Hartley-Krause	Recovery	Recovery	
Hartley-Krause	Recovery	Recovery	
Hartley-Krause preliminary ligation of external carotid	Recovery	Recovery	
Hartley-Krause	Recovery	Recovery	
Hartley-Krause	Recovery	Recovery	Curetted out ganglion.

however, may be serious enough in themselves. It is further hoped that the simple but essentially practical methods of diagnosis may also be generally helpful.

Development Factors.—A study of the embryonic sections and other illustrations (pages 547, 548, 559 and 566) clearly demonstrates that arrested development or restricted growth from any cause in the region of the mouth, the most common evidences of which are found in high, narrow palatal vaults, contracted dental arches, and irregular teeth, is chiefly an expression of abnormal developmental tendencies. These

defects are usually indicative of neurotic tendency and therefore of predisposition to painful as well as other neuroses. Moreover, such restricted growth invariably manifests itself by alterations in the form of surrounding structures. This is noticeably true of the general form and character of the maxillæ. Corresponding deviations from the normal are likely to occur in the maxillary and other closely related cavities, foramina, and canals, and the passage of nerves through such abnormal openings subjects them to irritation. Nasal defects, such as narrow nares, deviated septa, spurs, and hypertrophic and other pathological alterations of structure, are similarly frequent evidences of perverted development. A more detailed description of these conditions is given on page 546. Direct opportunity is thus offered for diseased conditions of the nose and associated parts, including the ethmoidal, sphenoidal, and maxillary sinuses and cells, as well as the orbital and aural regions. Through any of these the nerves may be involved in the disease itself or become affected by actual alteration in size or form. Anomalous communicating openings and channels may also favor pathological states. Many branches of the fifth nerve are thus exposed to disease or more or less direct irritation. Oral deformity or perverted maxillary development can unquestionably so change the shape of the orbits that the adjustment of its contents to their bony encasement may cause visual defects which may also be etiological factors of no small significance.

Disease of the middle ear through Eustachian infection, the cause and effect of which is well understood, and the pressure of crowded teeth incident to arrested growth of the jaw frequently cause irritation of the nerve. The effect of tooth grinding and jaw clinching in producing nerve exhaustion or irritation is described below.

The reflection of restricted growth in the maxillary region as affecting other bones, gives at least a reasonable ground for belief that by arrested or perverted development in infancy, important foramina at the base of the skull, notably the foramen ovale and the foramen rotundum, through which the vessels and nerves emerge, may also be sufficiently restricted in size or altered in form to favor pressure upon the nerve when for any reason the accompanying vessels may become distended.

This is worthy of due consideration, since the premonitory signs often appear for all the foregoing conditions at such an early age and the remedy at this stage is so simple.

BUCCAL CONDITIONS WHICH MAY EXERT PREDISPOSING OR EXCITING INFLUENCES, THEIR DIAGNOSIS AND CORRECTION.

Jaw Clinching and Tooth Grinding.—Almost without exception the grinding surfaces of the teeth of patients suffering from trigeminal affections show marked evidence of the effect of this habit. This

usually makes it possible to diagnosticate the tendency to pain even without knowledge or history of the case. Cause and effect are, however, so closely interwoven that it is practically impossible to differentiate between the two with sufficient certainty and exactness to warrant definite distinctions. This may be better understood by the explanation that tooth grinding and the disturbed rest which is associated with this habit may be caused by eye-strain, whether due to astigmatic or other visual defects, fatigue from long-continued use, nervous states induced by auto-intoxication or other toxic effects, neurasthenia, and similar nervous conditions. On the other hand, given any local or general excitant which may give rise to the habit of grinding or clinching the teeth at night, and we have at once a factor capable of exercising most potent influences in the production of pain in the head in a number of different ways.

1. The continued activity of the muscles of the jaws prevents perfect rest and is fatiguing in much the same sense as eye-strain, with this difference, however, that the ocular muscles are usually only active when the eyes are in use, whereas activity of the jaw muscles, when the habit is fully formed, continues both day and night. Relief of pain and prompt increase in weight and improvement of general health in patients for whom this trouble has been relieved by treatment, and the use of an appliance as described on pages 290 and 291 has shown this to be a factor of no small importance, whether primary or secondary.

2. The continued overuse of the teeth in this way gives rise to certain changes in the pericementum, the vessels and the nerves surrounding the apical ends of the roots of the teeth involved, and the cementum of their roots. This may be in the nature of a chronic pericemental hyperemia, which is the natural result of ischemia caused by forcing blood out of the vessels of the pericementum during the active pressure that is made upon the teeth, and the consequent hyperemia which follows the relief of this pressure. This congestion can and does cause pressure upon the nerve filaments as they pass from the end of the root of the tooth to join the main branch of the nerve, which in neurotic individuals is amply sufficient to set in motion very serious painful conditions.

Pericementitis.—In the acute form pericemental inflammation gives rise to pain which is frequently referred to other parts. The chronic forms, however, are alone significant in relation to neuralgia, and these only rarely, if at all, because of the effect that the tendency to culminate either in pericemental abscess or interstitial gingivitis prevents the continuous persistent form of irritation that is necessary for chronic reflex nervous manifestations.

Hypercementosis.—Hypercementosis, or thickening of the pericementum surrounding the end of the root by involving nerve fibers or by pressure upon surrounding nerve structures due to enlargement as this abnormal growth proceeds, is also a cause of pain.

Ankylosis.—Perhaps the most serious of all pathological changes that take place in the structures surrounding the roots of the teeth as a result of this tooth-grinding habit is the tendency of the roots of such teeth to become ankylosed. This belief is confirmed by a very large number of patients of the author, the crowns of whose teeth were abraded and worn in evidence of long years of tooth grinding. Their histories described pain of various kinds in the distribution of the fifth nerve, particularly periodical headaches. When effort was made to extract such teeth, large masses of alveolar process came away with the roots. Cross-sections of these, made by decalcification and cuttings from microscopic slides, disclosed the condition of ankylosis as shown by Fig. 144. With the disappearance of the pericementum as

FIG. 144.—Ankylosis of tooth root. Cross-section, showing root and attached alveolar process in case of chronic trigeminal neuralgia.

the encroachment of bone proceeds in the process of the development of the ankylosis, there appears to be constriction of the little nerve fibers which during the periods of the attack appear to be capable of giving rise to the most excruciating exacerbations of pain.

Diseases of the Dental Pulp.—Pulpitis.—The dental pulp is so richly supplied with nerves and bloodvessels, and by its very nature so highly susceptible to vasomotor stimuli, that enmeshed as these vessels are in connective tissue, the whole being surrounded by unyielding walls of dentin, its possibilities for giving rise to pain, and particularly pain of reflex character, are very great. Fortunately the tendency of an acute circumscribed pulpitis is rapidly to become diffuse

and pass to the stage where strangulation of the nerve by vascular pressure causes its devitalization, and through infection the formation of pus leads to dento-alveolar abscess. Although the process is often an exceedingly painful one throughout, its natural time limitation is such as to preclude the likelihood of its becoming a factor in causing chronic neuralgia in any form. There are, however, certain pulp degenerations which result from chronic pulpitis, long-continued irritation, and constitutional influences, or toxic effects in which no outward manifestation is given. Pulps under these conditions often retain vitality for many years, and may give rise to reflex pain of almost any character. Because of the absence of the usual appearance of diseased teeth, and as there frequently are no carious cavities nor outward signs of disease, their etiological importance is quite generally overlooked in diagnosis. Atrophy, fibroid, calcareous and other forms of degeneration, pulp nodules, and pulp tumors are vicious degenerative forms which affect pulps of teeth with a frequency not fully appreciated because not always detected. Each of these conditions has repeatedly been found associated with trigeminal neuralgia that has disappeared or been markedly benefited by treatment of the pulp canals or removal of the teeth.

Pulp Nodules.—Pulp nodules (Fig. 145) are undoubtedly present in the pulps of many persons who suffer no inconvenience by reason of the fact. When, however, there is individual predisposition to nerve disturbance or the presence of an excitant sufficient to induce hyperemia, the activity of the bloodvessels of such a pulp is insufficient to allow reaction in relief of temporary engorgement with the same rapidity as the vessels of a pulp not so affected. The hard substance of the pulp stone forced against the nerve fibers through counter-pressure of the unyielding dentinal walls of the pulp chamber, does, as might be expected, give rise to excruciating exacerbations of pain. In the absence of infection or traumatic injury such pulps may remain alive for many years, in fact almost indefinitely, their hyperesthetic condition becoming worse as time goes on. This is the condition found so often in association with tic douloureux (Figs. 146 and 147). The adventitious growth of dentin upon the dentinal pulpal walls may cause similar constriction and pain.

It must be understood that the foregoing cannot be relied upon as absolute indications that the first cause is in the teeth. Some of these symptoms are also found when the primary etiological factor is elsewhere, and are symptomatic of brain and other affections. For many years, however, they have served to point the way in large numbers of the author's patients, and have often helped to bring about the relief which has been given. On this account their importance cannot well be overestimated, recommended as they are by directness and simplicity as well as the possibility of conservatism and the avoidance of disfigurement and discomfort through loss of teeth which is thus offered. There is a wide difference of opinion among authorities

as to the frequency with which neuralgia may be central or peripheral. Most writers, however, are agreed that in a considerable number of cases the affection primarily is peripheral, and that in the course of time, as the disease continues to advance, more branches and deeper portions of the nerve become involved, until finally the Gasserian ganglion is attacked. In addition to this many cases are on record of pathological conditions of the teeth, mouth, and tooth pulps which could without doubt have caused reflex pain of serious character in patients suffering from tic douloureux and other forms of neuralgic

FIG. 145.—Section of the pulp of a tooth from the mouth of one of the author's patients, a woman, aged forty-five years, who had suffered for several years with tic douloureux. The tooth from which this pulp was removed was on the affected side and at the point where the earliest pain appeared to begin: *a*, *b*, pulp nodules.

FIG. 146.—Another section of the same pulp shown in Fig. 145. In addition to the nodules *a*, *b*, an accompanying pulp degeneration is particularly evidenced at *c*.

pain. Figs. 115, 116, 145, 146 and 147 are photomicrographs of sections of tooth pulps removed from the teeth of patients suffering from tic douloureux. They were isolated and their conditions diagnosticated by the methods given below. They show fibroid and calcareous degeneration with marked alteration of form, distribution, and character of the nerve fibers not dissimilar to indications (Plate X) of Gasserian ganglia. There seems every reason to believe that, either as a primary cause or as a result of the paroxysmal character of exacerbations of pain due principally to other and remote causes,

the continued irritation of tooth pulps because of their peculiar histological character and environment first gives rise to degenerative changes in these organs which later affect the nerve branches in more general distribution. Certainly, search in this direction and the treatment of even suspected tooth pulps should precede other graver methods of treatment.

Diagnosis.—General examination of the mouth and teeth with a view of determining the likelihood of peripheral irritation in this region should include examination of the general outline of the dental arch, face, and nose to note the possibility of ill effect from imperfect development as described.

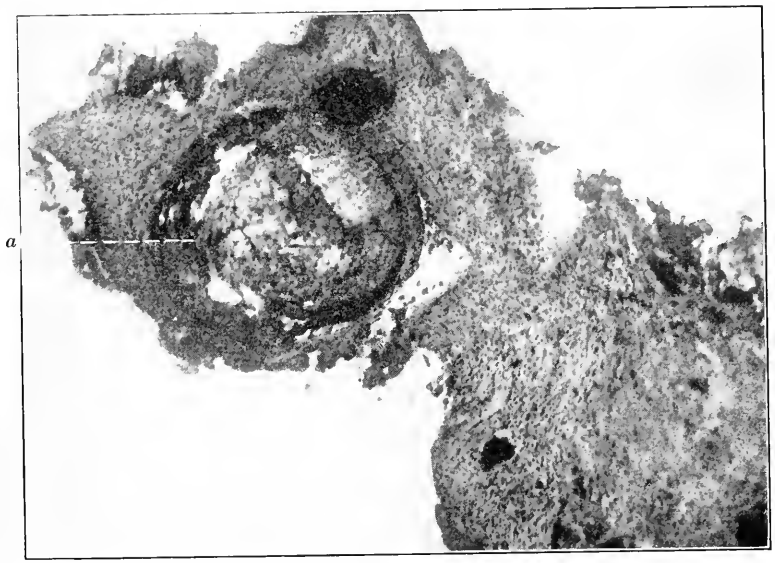

FIG. 147.—Pulp from the molar tooth of a man, aged forty years. Case of tic douloureux. The crown of this tooth showed no carious or other serious defect. *a*, pulp nodule.

Early Diagnosis.—Children of delicate nervous organization, especially when there is a known hereditary tendency, require close observation during their important development periods to detect any tendency to arrest of growth or asymmetrical form of the nose or mouth before harmful results have had opportunity to give serious manifestation. At later periods irregular dental arches, high, narrow palatal vaults, adenoids, enlarged tonsils, mouth-breathing, and the symptoms of imperfect oxygenation, and ill-nourishment that are associated with these conditions when present in conjunction with pain in the region of the fifth nerve render the diagnosis of causal factors of this character quite simple.

Diagnostic Indications after the Eruption of Teeth.—Examination of the occlusal surfaces of the teeth is of first importance, particularly

in cases in which they are abraded at points which do not come in contact in normal occlusion, as this is an indication of the jaw-biting habit. Patients are almost invariably unconscious of the habit, but usually after tooth surfaces that they have been accustomed to bite upon are ground until they no longer meet in occlusion, such patients, when next seen, as a rule, admit having noticed the loss of the grinding surfaces and are therefore convinced. Elongation or looseness of teeth points to chronic pericemental thickening. This may or may not be noticeable when jaws are closed. It may be diagnosticated by placing a finger inside the cheek or lips, allowing its palmar surface to rest against the buccal or labial surfaces of the teeth with light pressure. When the jaws are closed a slight movement of the affected tooth can sometimes be felt, even though not noticeable in other examinations.

Study of the *color of the mucous membrane* of the lips and mouth and the appearance of the gums, salivary and other glands in the buccal region indicates the general state of the patient, and shows whether he is anemic or affected by auto-intoxication or any other general disturbance which might be an etiological factor. *The presence or absence of carious or diseased teeth* should be noted, with particularly careful search for a carious tooth cavity through which a pulp might have become exposed to undergoing chronic degeneration of any kind. Metal crowns or bridge-work that might indicate tooth grinding should also be noted. The *occlusal surfaces* of the molars and bicuspids and incisal portions of the six anterior teeth should be examined, with careful observation of the worn surfaces of the enamel or bright shining spots in fillings. The *mandibular articulation* must receive attention to note whether there be undue enlargement or other abnormality in the region of the temporomaxillary articulation. *The teeth must be carefully counted* and the presence or absence of each tooth accounted for, particularly the third molars. If there be doubt or uncertainty in this respect, a radiograph should always be taken to determine whether malposed, unerupted, or supernumerary teeth exist. The necks of the teeth should be examined at points where recession of the gum may have exposed sensitive dentin to irritation. This has been reported as a cause by Inglis. Difference in color must be carefully observed with reflected light through the crown of the teeth, if possible with an electric mouth lamp. Discoloration indicates devitalized pulps or pulp calcification, teeth of this character being somewhat darker than the crowns of normal living teeth. The *size* of all *fillings* must be compared *in proportion to crowns* of teeth filled, to form an idea as to the likelihood of the filling having been placed too close to the pulp chamber. *Improperly constructed bridge-work* with imperfect occlusion and cases in which teeth or roots have been used as abutments and suffer too great strain in carrying too many bridged teeth should be noted; also cases in which there is an abutment at only one end of the bridge, one tooth being allowed to support crowns to supply one or more missing teeth. Any of these conditions would lead at once

to suspicion of pericemental diseases which might be expected to lead to chronic pulp affections. In certain forms of trigeminal neuralgia the *pain* quite frequently is *greater at night or when the patient is lying down*. While this is sometimes a symptom due to other causes, it is at least a reasonably good indication that the causative factor lies in some form of pulpitis, as in diseases of the dental pulp. The change in posture favoring increased circulation of blood in the upper portion of the body almost invariably gives the onset or increase of pain. This was very marked in one of the author's patients. The history of this case as given by the physician who referred him was that during a period of a number of weeks the man had suffered from excruciating unilateral trigeminal pain. Morphin had been administered up to the limit of safety, but it seemed to be impossible to give relief when the patient was lying down. When he stood up relief was so prompt that he slept without difficulty by leaning against the wall in an erect position. Diagnosis of the cause was quickly made, and an upper molar tooth extracted which to all outward appearances was perfectly sound. Upon breaking the tooth open the pulp chamber was found to be filled with pulp nodules, and the pain disappeared almost immediately.

Percussion with a steel instrument may disclose tenderness to tapping, or there may be no abnormal evidences other than a slight dulness of sound which distinguishes teeth having pathological conditions of the pericementum. *Ankylosed teeth* give a slightly sharp or ringing sound on percussion, because the deadening effect of the pericementum which normally acts as a cushion is lost by its obliteration.

Bulging or Enlargement of the Alveolar Surface Over Roots.—Hypercementosis that has progressed to a sufficient extent by encroachment upon surrounding alveolar structures sometimes gives the appearance of growth at certain points over the roots, which, taken with the altered resonance of percussion, assists the discovery of this condition. This form of diagnosis has many times led to the location of teeth which were exciting factors in painful neuralgias. In one of the author's cases, a woman with hyperesthesia so marked that she admitted not having washed her face for more than three months, the sensitiveness was such that touching the lips almost anywhere brought forth extreme paroxysms of pain, and under these conditions, which made diagnosis extremely difficult, no important guiding symptom was found other than dulness on percussion of an upper bicuspid tooth. Immediately following the extraction of this tooth the hyperesthesia disappeared and upon breaking it open the pulp chamber was found filled with a finely granulated powder resulting from calcareous degeneration of the pulp. This did not completely relieve the patient, but the distressing hyperesthesia was at once relieved and other painful symptoms much improved.

Skiagraphs carefully taken sometimes assist diagnosis very materially, especially when hypercementosis is marked. They are exceedingly useful in disclosing diseased conditions of the roots of teeth

sufficiently, when these have been imperfectly filled. Many interesting examples of the value of skiagraphy might be shown in which the cause of long-continued irritation at the apical portion of the root of the tooth has proved to be the projection of a root filling beyond the apical foramen or through some opening in the side of the root. Dento-alveolar abscesses, pericemental abscesses, and diseased conditions of surrounding alveolar structures, particularly unusual necrotic conditions, have been disclosed in this way. In the various forms of *pathological dentition*, such as malposed, unerupted, or supernumerary teeth, especially with delayed dentition, dentigerous cysts, and odontomes, the *x*-rays are useful beyond all other diagnostic aids. Pus, tumors, and foreign bodies in the maxillary sinus may sometimes be advantageously determined by the use of the *x*-rays.

No other agent is equally useful in ascertaining the exact conditions of recent *fractures* of the jaws in which union has been delayed or faulty, is complicated by necrosis and malposition of the bones, or has taken place without correct approximation with consequent permanent deformity or pain from pressure upon nerves and palate vessels.

Sensitiveness to Heat and Cold.—The most important test of a tooth pulp as indicating healthfulness on the one hand, or impaired vitality on the other, is its reaction to heat, cold, and other forms of irritation. A normal pulp should react quickly to irritation with sharp pain if sufficiently disturbed, but with the vitality and its vascular supply unimpaired, the transient hyperemia induced by stimuli of this character should be promptly relieved. Therefore the pain should disappear quickly. Lessened sensitiveness indicates lowered vitality. Slowness of disappearance of pain indicates loss of circulatory activity probably due to chronic hyperemia and the impaired ability of the coats of the vessels to free themselves, indicating the partial stasis of inflammatory processes or other degenerative changes.

The temperature test of a pulp then consists in the suddenness of the onset of pain upon application of heat or cold and the promptness with which the pain disappears. The same is true of other irritations. When pulpitis is present the pain may continue for a few minutes or a few hours, or reflex disturbance of important serious character may be excited. This also is an indication that degenerative processes have become sufficiently advanced to involve more distant portions of the nerve supply. Applying this knowledge to the diagnosis of neuralgia, we recognize that the onset of pain when breathing cold air through the mouth, when riding or walking, or increase of pain upon entering a warm room from outer cooler air, may be taken as indications of peripheral irritation from some hypersensitiveness or diseased tooth pulp. The onset or increase of pain when hot, cold, sweet, or sour substances are taken into the mouth may be taken as a fairly good indication of tooth pulp disturbance. The cessation of pain when the mouth is filled with iced water which is held there and changed

with sufficient rapidity to insure continued cold is another indication, because at a certain stage of pulpitis the application of ice, iced water, or any form of sufficiently cold application will stop the pain. At an earlier or later stage of the pulpitis, even in the same tooth pulp, this might excite intensely painful symptoms, but at just the right moment the contraction of the vessels by cold gives prompt relief. In testing individual teeth for temperature changes care must be exercised to isolate each particular tooth in order that one may accurately determine exactly which tooth is the exciting cause. Too often both heat and cold are applied in a more or less general way, and although the indications may lead to diagnosis of dental trouble the particular teeth involved are not so readily discovered. A simple way of applying heat is to take a mass of dentist's base-plate gutta-percha as large as the first joint of a little finger, hold with an instrument in the flame of a spirit lamp to soften the gutta-percha, roll into a mass, and point it at one end so that when applied to the tooth only one may be touched at a time. When this is applied as hot as it can be made without burning and with care to avoid touching the gums, the response of each particular tooth in the mouth to heat may be accurately noted. Teeth which fail to respond are probably devitalized, and care should be taken to know that each tooth of this kind has been properly treated and its roots filled. If pulps are alive the response of all teeth will be approximately the same. Variations from this should be noted. When pain appears immediately in the track of a neuralgia at some more or less distant point in the distribution of the fifth nerve upon the application of heat in this way, and this pain continues longer than the normal time required for the tooth to regain its usual temperature, it is an indication that the pulp of such a tooth or teeth must receive treatment.

The simplest way to apply cold is to take a piece of ice, sharpened to a point at one end, of such shape that it can be wrapped in a napkin and held without difficulty, and each tooth touched one after the other with the sharp-pointed exposed portion of the ice. The indication and inequality and situation of pain excited, and the time required for its disappearance are the determining factors as with heat. Tests of this kind are particularly useful in leading to the discovery of pulp nodules or fillings that have been placed too close to the pulp chamber. Quite frequently pulp stones are discovered in this way when tooth pulps having such symptoms have been removed that could have been discovered in no other.

Treatment. — With children or young persons as a prophylactic measure the natural remedy is expansion of dental arches, by separation of the maxillæ to widen the nose. This gives the benefit of more perfect physiological respiration, assists the natural eruption of developing teeth, and gains the general developmental benefit of improved respiration. This is described more in detail in illustrations, pages 555–558.

The question of treatment of teeth in neuralgic patients, particularly those suffering from major neuralgia or tic douloureux, is often a serious matter. With or without real cause patients quite often suffer pain in a particular tooth, and they are always desirous of its extraction. But it should be remembered that almost invariably as much can be done to give relief by removal of the pulp and the proper treatment of the root canals, thus disposing of the irritating factor as completely as if the tooth had been extracted. On the other hand, every time a tooth is extracted the occlusion of the jaws is disarranged, as has been already noted. Such patients during the paroxysms of their suffering always clinch and grind their teeth. While temporary relief can be given by the extraction of a particular tooth that is elongated, tender to touch, or that has a diseased pulp, almost invariably within a short time after its extraction one of the adjoining teeth becomes similarly affected. Being deprived of the natural support which each tooth gives to its fellow in the dental arch, it more readily succumbs to the overuse thus brought about, and pulpitis from irritation of the pericementum affecting the nerves and vessels where they enter the apical foramen is quickly conveyed to the tooth pulp itself. Thus it is a common experience to find patients who have had all of the teeth upon the affected side extracted one after the other, or when all have not yet been removed and a few taken out, the remaining teeth are found leaning at a very considerable angle, having been forced out of position by the unusual stress to which they have been subjected. The indiscriminate extraction of teeth in this way seldom ever does permanent good and almost always more or less harm.

Dentists are sometimes reluctant to destroy more or less ruthlessly the pulps of teeth that are outwardly perfect in appearance, and such opinion, based as it is upon true conservatism, is entitled to respect. But it must be remembered that the value of a dental pulp or even of teeth when compared with the suffering and other physical disadvantages which follow in the train of neuralgia of grave character should not be allowed to weigh in the balance to any considerable extent. It is an exceedingly simple procedure for a skilful dentist to open a suspected tooth, and by cocainizing the pulp with pressure anesthesia to remove it painlessly, and with proper treatment to fill the root canals, thus preserving the usefulness of the tooth, not only for its original masticatory and cosmetic purposes but as a safeguard against the continued progress of the dental irritation through the influence of the affection itself.

Malocclusion must be corrected by grinding the surfaces of teeth that have become elongated or by proper dental operations to prevent undue stress upon the affected teeth. Grinding the surfaces of the teeth which are most abraded to overcome the habit and various other expedients have been found useful to prevent tooth grinding at night, such as tying rubber, cotton, or other materials over the surface of one or more back teeth to keep the jaws slightly apart, gum held between

the jaws at night, etc. Much relief has been given to large numbers of patients during several years past by the insertion of an appliance called, for want of a better name, the author's soft-rubber bit (Fig. 148). This is an exceedingly simple but very useful appliance, made as shown with a hard-rubber plate fitting the palate and having soft velum rubber extending over the crown surfaces of the teeth one-eighth to one-quarter of an inch in thickness. The soft yielding surface of the rubber, when the jaws are brought in contact, prevents undue irritation of individual teeth. The effect of the appliance in the mouth and the inability to bring into contact the tooth surfaces that have been held tightly together or have been ground during subconscious moments and sleep in time helps to overcome the habit. The steadiness which is given to the lower jaw when forced against the upper relieves nerve tension in such individuals very materially. In most cases certain changes in the way of enlargement have taken place

FIG. 148.—The author's rubber appliance to relieve stress in case of "jaw-clinching habit" and nervous tooth grinding. The palatal portion is made of hard vulcanized rubber, and the covering for the occlused surfaces of the teeth is of soft velum rubber.

in the region of the temporomaxillary articulation which allows a much greater irregularity of movement of the jaw than is normally the case. The continued seeking for a proper resting place is one of the marked symptoms, and has invariably proved to be an important factor in relation to nerve strain and irritation. Many patients could be cited who have been completely relieved by this treatment.

A young lady, aged twenty-three years, suffered for five years almost constant pain, chiefly in the occipital region, but at times involving also other regions. Her sleep was much disturbed, and she usually awoke in the morning with the pain much worse. Her symptoms finally became so bad that she lost self-control almost entirely. No other treatment was given except the constant wearing of this appliance, hygienic care, and rubbing with alcohol for relief during acutely painful periods. In a little while she became absolutely dependent upon the appliance, and in the coarse of time the trouble gradually and completely disappeared.

Another young woman, aged forty years, a chronic sufferer from neuralgia, who, although five feet three and one-half inches in height, weighed only ninety-seven pounds when the appliance was inserted, was relieved in the same way.

Temporomaxillary Articulation.—Examination of skulls in the cadaver and dried specimens as well as observation and study of the movement of the condyles show great variation in size and form of the glenoid cavities of different individuals and often on the two sides of the same individual. This manifests itself as a factor in the production of certain diseases of the teeth and their surrounding structures. It also may become an influential factor in the production of pain. There are many cases on record in which trigeminal neuralgia has been relieved by the insertion of suitable plates to hold edentulous jaws sufficiently apart to keep the condyloid and coronoid processes of the lower jaw in right relation to the surrounding parts. In the same way persons have been relieved by elongation of teeth by dental operations when the crowns have become so abraded as to allow the jaws to come too close together. Cysts, particularly the dentigerous cysts of erupting teeth, sometimes cause pressure upon important nerve branches. Engorgement or empyema of the maxillary sinus through pressure of fluid is a frequent source of irritation of the second division of the nerve.

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LESIONS OF THE FACIAL (SEVENTH) NERVE.

Anatomical Relations.—The commonly accepted belief that the seventh or facial nerve is entirely a motor nerve is questioned by more

recent investigators. Its main distribution, however, is to the muscles of expression. Its point of origin is the inferior portion of the general motor areas ventral of the fissure of Rolando. The axons pass into the pons accompanying the general motor tract.

The peripheral nerve in its passage from the nucleus forms a loop about the nucleus of the sixth nerve, thence passes ventrally to emerge in close relation with the auditory nerve, separated by it from the pars intermedia (nerve of Wrisberg). These nerves together pass into the internal auditory meatus. Centrally it is connected with the upper part of the glossopharyngeal nucleus, and may improperly be regarded as forming the sensory portions of the seventh nerve and the main part of the chorda tympani. The seventh nerve, peripheral to the geniculate ganglion, passes into the Fallopian canal, runs between the cochlea and vestibule into the inner wall of the tympanum, separated from the tympanum by a thin lamella of bone and lining membrane of the middle ear, finally emerging from the skull through the stylomastoid foramen. The geniculate ganglion lying at the bend of the nerve corresponds to a ganglion of a dorsal root. In addition to the supply of the facial muscles of expression, the facial nerve sends fibers to the platysma, posterior belly of the digastric, the stylohyoid, and a small twig within the Fallopian canal to the stapedius muscle of the ear.

Facial Paralysis.—Paralysis of the seventh nerve is more frequent than that of any other nerve in the body. In a large majority of cases the affection is unilateral and caused by a lesion in peripheral distribution of the nerve.

Etiology.—Its known and suspected causes are many, and given in the order of their importance are approximately as follows:

Exposure.—It has been estimated that 70 per cent. of all cases show this etiological factor, and though the reason does not seem to be clear, facial paralysis occurring after exposure to draughts or similar conditions so overshadows other factors in frequency as to warrant its enumeration as an exciting cause.

Suppurative Ear Disease.—Suppurative ear disease is extremely common because of the close proximity of the Fallopian canal through which the nerve passes to the frequently diseased auditory region.

Trauma.—Injury of direct character to the nerve itself or surrounding structures is a common cause, especially surgical or other division of the nerve.

Basal Fractures.—Thomas states that in 69 cases of nerve involvement from skull fracture, 34 showed an affection of the facial nerve.

Disease of the Base of the Brain.—Meningitis, new tumor growths, and affections of the medulla and pons, readily lead to involvement of one or both facial nerves.

Neuropathic Tendency.—While predisposition of this character plays a part in this as with other nerve affections, it does not seem to warrant important consideration as a direct factor, although instances

of the occurrence of facial paralysis affecting more than one member of the same family prevents complete exclusion of this contributing factor.

Constitutional Disease.—Gout, diabetes, leukemia, syphilis, tuberculosis, and similar conditions may be factors of primary or secondary importance, as may also the *puerperal state and diphtheria.*

Emotional Shock.—Emotional shock has in a number of instances been followed by facial paralysis.

Neuritis.—Neuritis or a primary degeneration of the nerve within the aqueductus fallopii have, in a limited number of cases reported by Andre Thomas, been demonstrated to be active factors in this affection.

Polyneuritis.—Polyneuritis may occur in conjunction with this condition, and in these cases the paralysis is usually double-sided.

Poliomyelitis.—Atrophy and paresis of the tongue and pharynx sometimes follow the symptoms of general emaciation and muscular fibrillation, which are indicative of degenerative conditions of the spinal cord.

Periods of Life.—Periods of life bear their usual importance in this relation. Paralysis of the facial nerve is more frequent before forty and more severe though less frequent in later life.

Symptoms.—The onset of the facial paralysis is usually rapid. Pain located in the ear, the mastoid region, or neck sometimes occurs as a premonitory symptom, but with too little certainty to warrant diagnostic or prognostic dependence. There may be fever and other signs of infection at the onset. The most prominent symptom is complete or partial loss of movement of the muscles upon the affected side of the face. Paralysis of the orbicularis oculi prevents closing of the eyelid. Attempts to close the eye result in the globe being rolled upward. In smiling, the mouth is drawn toward the unaffected side. The lips cannot be properly adjusted in attempts to whistle. Drinking and speech are interfered with (Figs. 149 and 150).

Spasmodic Contraction.—Spontaneous twitching of the face muscles, particularly the zygomatic muscles, may be a secondary symptom, and continue for years or be totally beyond hope or recovery. Without conclusive evidence it is generally assumed that this occurs through degenerative progress, which involves the pons and causes loss of control of nerve impulse, which therefore proceeds irregularly and in excessive degree. (Facial spasm, tic, etc., see Spasmodic Neuroses, page 303.)

Location of the lesion is sometimes possible through consideration of the following symptomatic distinctions:

1. Between the exit of the nerve from the stylomastoid foramen, taste is not affected because the chorda tympani joins the nerve above these points.

2. Between the stylomastoid foramen and the geniculate ganglion within the Fallopian canal. Taste in the two-thirds of the anterior

part of the tongue so affected through constant involvement of the chorda tympani.

3. Between the geniculate ganglion and pons. There is no involvement of taste, deafness is often associated through involvement of the auditory nerve.

4. In the pons, taste and hearing are unaffected, and almost invariably the six principal other nerves are all affected. In the central course of the facial nerve no changes in the electrical reaction occur, the upper branch of the nerve is much less involved than the two lower.

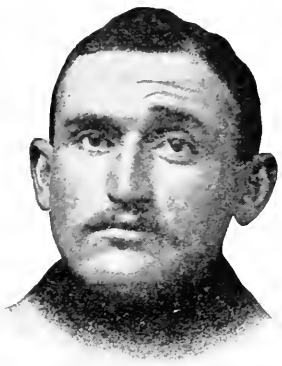


FIG. 149. — Facial paralysis of the side. Attempt to raise the eyebrows. (Starr.)

FIG. 150.—Facial paralysis of the side. Attempt to close the eyes. (Starr.)

Diagnosis.—In a general way diagnosis is obviously simple, but it is especially important to differentiate between a central disturbance in the nerve and one due to a peripheral cause. The distinguishing features in making this differential diagnosis are as follows:

CENTRAL.	PERIPHERY.
1. No change in electrical reaction.	1. Electrical reaction always present.
2. Upper branches of the peripheral nerve are slightly involved.	2. All branches of the nerve equally involved.
3. Reflex conditions of the nerve increased but electrically unchanged.	3. Reflex activities diminished with tendency to ultimate atrophy.
4. A crossed or alternating hemiplegia indicates a lesion in the pons below the crossing of the pyramid.	4. No such condition possible.

Traumatic injury to a special branch of the nerve may in a measure modify all radical lines of distinction.

Prognosis.—The duration as well as the final outcome in these cases varies from one or more weeks to months or may be permanent. There may be recovery even with complete reaction of degeneration. When this condition, however, persists for months and a quantitative diminution of electrical excitability results, the prognosis is grave

because of permanent changes in the nerve or destruction of the pontine nucleus. In a general way it may be assumed that with electrical reactions normal or nearly so and the period short, prognosis would be favorable, and with loss of electrical reaction and increased length of time hope for recovery be correspondingly diminished.

The following clinical example illustrates the difference between central and peripheral causes in the author's cases:

A young man, aged twenty-four years, unmarried, with facial symptoms as indicated in Figs. 151 and 152, gave a history of paralysis having continued through a period of several weeks. He had also extensive necrosis of the lower jaw involving several teeth which was treated by the removal of the diseased tissue, but no portion of the facial nerve was found to be directly involved. His death, some time after leaving the hospital, revealed the fact that his affection was of central origin. There was no opportunity for definite location of the nature of the lesion by autopsy.

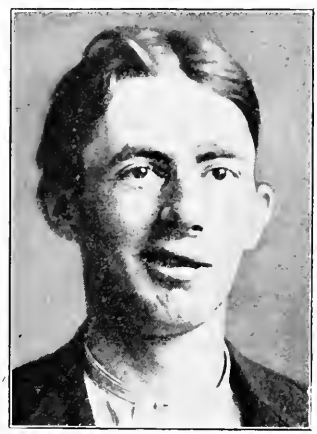


FIG. 151.—Facial paralysis.

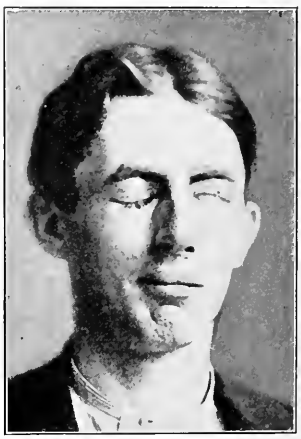


FIG. 152.—Facial paralysis. The effect of an attempt to close the eyes.

Another of the author's patients, a young woman, aged about twenty-six years, married, had symptoms affecting the right side of her face quite similar to those of the young man just described. Paralysis occurred a few days before presentation for treatment. There was suspicion of syphilis in this case, but no definite diagnosis. The removal of a diseased third molar upon the affected side caused marked improvement an hour or so later. When she returned home her husband was surprised and astonished at the change. Following this, the symptoms improved slowly, and in the course of a few weeks completely disappeared. Whether the irritation from the pulp of the third molar was merely a contributing factor, and the removal of the tooth through the stimulating effect of the shock of pain aroused was

responsible for the improvement, or if by some anomaly there was in this individual an unusually close interweaving of sensory and motor elements, or if such relation is really more common than generally supposed, is of course impossible to say. There can be no doubt, however, of the fact that irritation in the maxillary region, especially when the living pulps of the teeth are involved, has an active influence in such cases of secondary if not primary character. For an old lady, aged sixty years, with muscular spasm which affected the right side of the face and involved the superior and inferior branches of the fifth nerve, the removal of diseased pulps and correction of malocclusion, which was aggravated by long-continued tooth-grinding habit, as commonly noted in many nervous states, seemed to give a measure of benefit even though complete relief from the muscular twitching was not accomplished, and the affection was undoubtedly due to a central cause.

Treatment.—The treatment is radical or otherwise. Effort should be made to correct any associated pathological condition which might possibly be an exciting or contributing factor. Nature must be assisted in every possible way to further natural corrective processes. Medical treatment should therefore be to keep the bowels freely active, and include the administration of salicylates when indicated, treatment of syphilis, if this disease be recognized as an etiological factor, by the use of iodides and mercury, and the relief of any etiological factor that may be benefited by external medication. If there be symptoms of neuritis within the Fallopian canal, hot fomentations may be applied in the mastoid region, or direct treatment of the affected parts is still better. Electricity is probably more extensively employed than any other agent, and though there seems to be some doubt as to its permanent benefit, it appears to be the most rational means of stimulating nerve and muscle activity and protecting against degenerative progression.

Dr. E. Farquhar Buzzard gives the following outline of electrical treatment: "In treatment by these means, presuming that a reaction of degeneration is present, the galvanic current should be employed, using over the affected muscles the pole which produces the most marked contraction. No more than four or five milliampères should be used, and the muscles should be stroked by an electrode for a period not exceeding ten minutes. As the faradic irritability returns, this form of electricity may be substituted for the constant current, but it is well to discontinue any form of electric treatment when the tendency to contracture and spasm of the muscle becomes apparent. There is no adequate evidence to show that the application of electricity plays no part in the production of secondary contracture, but the treatment becomes more and more superfluous as voluntary control over the muscles increases, and may well be discontinued before such voluntary control becomes complete."

Surgical Treatment.—Anastomosis of the facial with the spinal accessory was accomplished by Ballance in 1895. The objection

proved to be tendency to paralysis of the trapezius and sternomastoid muscles and involuntary movement of the shoulder. Through similar efforts by Cushing, Faure, Hackenbruch, Kennedy, and others, the hypoglossal nerve was substituted for the spinal accessory, and by only partial division of the hypoglossal difficulties of deglutition and speech, which followed complete division of this nerve, were avoided.

Surgical intervention of this character could only be expected to be efficient in cases of traumatic injury or division of the facial nerve, destructive middle-ear disease, and conditions of similar character. To be effective, the operation should be done at the earliest possible day after it has been determined that constructive processes cannot be looked to for improvement because of the danger of muscle disintegration through inactivity.

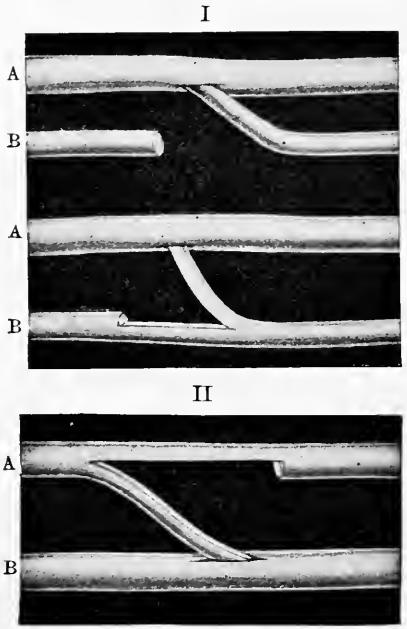


FIG. 153.—Nerve anastomosis: *A*, intact nerve; *B*, paralyzed nerve; *I*, lateral anastomosis (peripheral implantation); *II*, lateral anastomosis (central implantation). (After Brewer.)

Improvements in the surgical technic and better understanding of the possibilities of nerve anastomosis are encouraging efforts in this direction (Figs. 153 and 154). Good results have been obtained by Keen, Ochsner, and other surgeons in directly suturing the ends of divided nerves and bridging across with gut sutures between them, when the nerve ends could not be brought into direct contact. The wonderful regenerative power of nerve structures which enables them to cross bridges of this character and become perfectly united with

restoration of function has thus been demonstrated. These facts lead to the belief that in the future divided ends of the facial nerve may thus be united without resorting to anastomosis of the hypoglossal. Certainly, wherever the point of injury or division of the nerve is so situated as to make direct union possible, this method would be favorable.

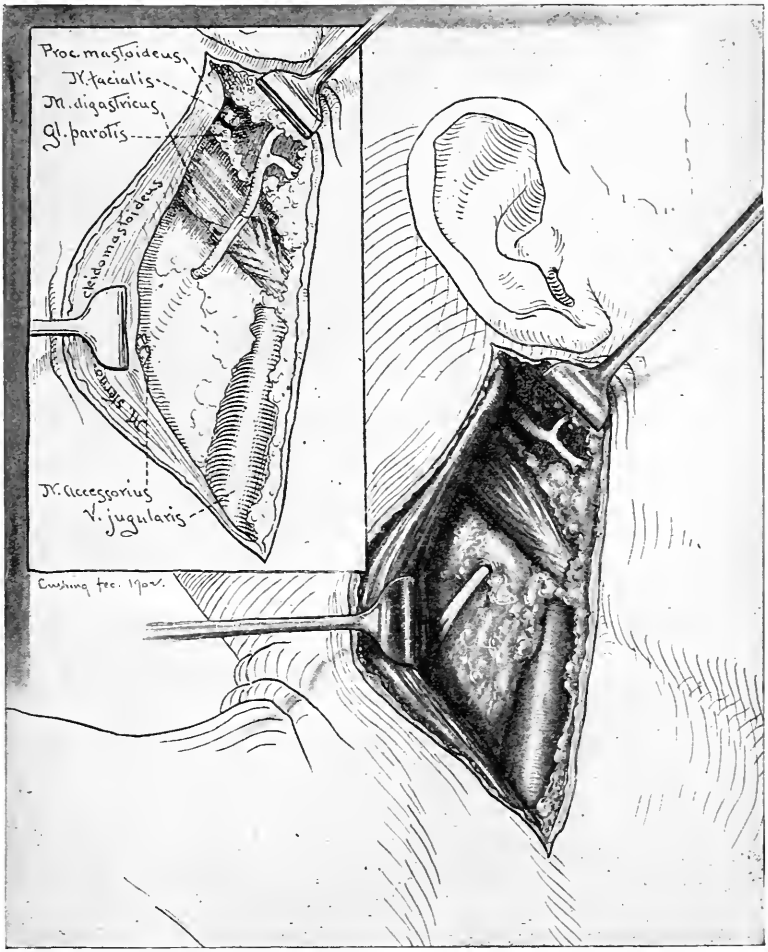


FIG. 154.—Illustrating method of fascio-accessory anastomosis. (Harvey Cushing, after Brewer.)

LESIONS OF THE AUDITORY (EIGHTH) NERVE.

The two distinct divisions of the auditory nerve, first the cochlear portion, in which the organ of Corti with its delicate mechanism for the special sense of hearing is situated, and the vestibular portion, which bears such an important relation in the phenomena of equilib-

rium, are both closely related in various ways to disease in the oral region.

Deafness is most commonly due to diseases within the ear affecting the peripheral fibers of the nerve; occasionally, however, hearing is disturbed by affection of the acoustic nerve. In these cases there is loss of power of perceiving sound through the bones of the head, and it is thus distinguished from deafness in the outer or middle ear, in which the sound of a tuning-fork can be heard when applied to the teeth, forehead, etc.

Tinnitus Aurium.—Ringing, ticking, hissing, roaring, or whistling sounds in the ear occasion the individuals so affected much distress.

Although the auditory apparatus accustoms itself to the almost constant sounds of daily life, so that they make little or no conscious impression, subjective sounds due to morbid processes cause an increase rather than a decrease in distressing effect upon the individual.

Etiology.—*Pathological Conditions of the Ear.*—These are located especially in the labyrinth, but include also wax in the external auditory meatus and affections of the middle ear. Quinine, the salicylates, and other drugs may give rise to tinnitus.

Circulatory Disorders.—Circulatory disorders, such as anemia, abnormal pulsation of the carotid artery, intracranial aneurysm, vasomotor palsy of the labyrinthian vessels, arterial sclerosis, high or low-pressure, may cause tinnitus.

Nervous States.—Tinnitus is not commonly associated with hysteria, neurasthenia, epilepsy, and migraine, or the higher centers of the cerebral cortex may be so affected as to give rise to more complicated auditory hallucinations.

Muscular Movements.—Movement of the palatal muscles or drumhead, which may be voluntary or involuntary, accompanied by spasmodic contraction of the muscles of the face or otherwise, gives rise to a clicking sound produced by sudden separation of the moist agglutinated walls of the Eustachian tube.

Diagnosis.—The oral surgeon's special interest in this affection lies in the possible relation between diseased conditions of the mouth and maxillary sinus to middle-ear disease; in local irritation from tooth grinding, diseased pulps, or similar factors, which tend to aggravate general nervous conditions; the influence of buccal pathological states upon the blood and general disorders, which are recognized as factors of etiological importance, and in results of operations for correction of cleft-palate involving the palatal muscles and their part in control of the Eustachian opening. In the author's practice a considerable number of cases have had chronic empyema of the maxillary sinus, coincident with tinnitus, which was undoubtedly due to middle-ear disease. The general involvement of mouth, nose, maxillary sinus, Eustachian and mastoid regions, usually make it difficult to determine the exact primary cause. In some cases, however, direct connection with dento-alveolar abscesses and the history of onset of the symptoms following

development of the abscess upon the root of a tooth, left little doubt as to the rightful precedence of this cause. Certainly no treatment could be expected to be permanently effective so long as reinfection of the ear from the sinus or the mouth was possible. Therefore the diagnosis of these conditions and their proper treatment is exceedingly important. Recognition and correction of other mouth affections are also in varying degree important for the same reason.

Differential Diagnosis.—Differential diagnosis in these cases is sometimes extremely difficult, and only examination by an otologist can be effective in distinguishing between the different forms of this affection when due to diseased conditions of the ear. To recognize pathological states which might be of etiological importance and apply the test of their correction when possible appears to be the only safe rule for diagnostic guidance when the true cause is not apparent. Deafness does not seem to bear a definite relation to this trouble, since it may decrease with increasing deafness or remain unchanged.

Prognosis.—The prognosis is usually not hopeful. In large numbers of cases the affection tends to persist in spite of every treatment.

Treatment.—Although treatment is usually ineffective, the utmost effort should be made to remove or correct any predisposing or exciting cause that may be indicated. Diseases of the ear, maxillary sinus, nose, throat, or mouth should be given immediate attention. The psychic element always requires intelligent consideration with patients so afflicted, for cheerful, helpful, hopeful suggestions are at least encouraging and often beneficial. Conditions of the blood and general disorders of that character must be corrected if possible. Change of air, scene, and occupation, and the administration of nervines, tonics, or other internal medication may be required.

LESIONS OF THE GLOSSOPHARYNGEAL (NINTH) AND PNEUMOGASTRIC (TENTH) NERVES.

The ninth nerve contains both sensory and motor fibers, and is the nerve of common sensibility of the pharynx, palate, and middle ear. It is believed that it supplies sensation of taste to the posterior third of the tongue, the anterior two-thirds passing in through the lingual nerve. Confusion on this point has occurred by reason of the fact that division of the root of the trigeminal nerve has sometimes caused total loss of taste, and there is reason to believe that individuals differ somewhat in this respect.

The association of this nerve in both its motor and sensory fibers with the vagus or tenth nerve (pneumogastric) is so intimate that clinically a radical division is practically impossible. Injury of the motor branches causes anesthesia of the pharynx and larynx, with difficulty in swallowing. In bulbar paralysis there is loss of action of the esophagus, pharynx, and larynx. The wide distribution of the tenth nerve, however, with its control of respiratory and cardiac

centers, and its well-known susceptibility to sympathetic effect, renders the association of diseases of these nerves with pathological conditions of the mouth matters of much general importance.

LESIONS OF THE SPINAL ACCESSORY (ELEVENTH) NERVE.

Paralysis.—Etiology.—Among the usual causes of paralysis of the accessory nerve, we find swollen glands, abscess of the neck, and similar affections. The frequency with which these conditions occur from buccal infection requires at least a passing consideration.

Symptoms.—Paralysis of the sternocleidomastoid and trapezius muscle through loss of compensatory action causes the head to be turned backward and over the shoulder, which is also elevated. There is loss of power to raise the arm above the horizontal line through failure of the trapezius to counteract the serratus muscle, which retains the scapula in such manner as to produce a slight elevation upon the one side of the neck by the projection upward of its inner angle. Torticollis, or wry-neck, may be due to congenital lesions of the eleventh nerve, defects of deformity, or injury.

Diagnosis and Treatment.—Treatment, except when other causes are obvious, should include thorough examination for sources of infection in mouth or its associated glands and immediate correction of such existing conditions if any. Beyond this its consideration passes outside of the oral surgical and therapeutic domain.

LESIONS OF THE HYPOGLOSSAL (TWELFTH) NERVE.

Paralysis.—The hypoglossal nerve being purely motor and supplying all of the tongue muscles except the glossopalatini and geniohyoid, paralysis of this nerve is evidenced by motor and trophic changes in the tongue.

Etiology.—As with facial or other paralysis, its primary cause may be central or peripheral, although rarely involved in lesions upon the base of the brain. It is a quite prominent feature in bulbar paralysis. Traumatic injury, tuberculosis, syphilis, and other diseases identical with those enumerated as leading to other forms of paralysis may be causes (Fig. 155).

Symptoms.—Prominent symptoms are inability to move the muscles of the tongue or to protrude it from the mouth. One or both hypoglossal nerves may be affected. If both, there will be general loss of lingual motion. If one nerve only be involved, when the tongue is moved its tip will project toward the paralyzed side. This becomes more and more apparent as the tongue is extended out of the mouth. Mastication and deglutition are interfered with. Atrophy is a marked symptom if the lesion be peripheral and folds or ridges upon the otherwise smooth surface give indications of its progress (Fig. 156).

Prognosis.—Its termination naturally depends upon the seat of origin and the nature of the causative factor.

Treatment.—As with other forms of paralysis, treatment must be directed toward relief of the underlying condition.

FIG. 155.—Gunshot section of left hypoglossal nerve. (After Roberts.)

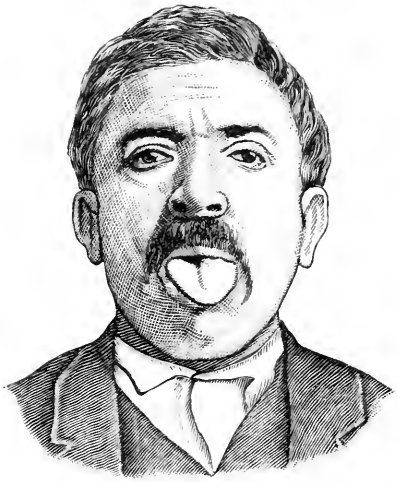


FIG. 156.—Right hemiatrophy of the tongue.

SPASMODIC NEUROSES.

Convulsions.—*Clonic spasm* is an alternate muscular contraction and relaxation that is violent and involuntary. *Tonic spasm* is a rigid contraction of muscles without relaxation. When slight it is called tremor; when strong and permanent, tetanus, trismus, etc.

Etiology.—In most cases fits occur before the completion of the first dentition. Of 300 cases studied by Cautley, 44 were in the first six months of life, 52 in the second, 76 in the second year, and 44 in the third year. Of these, no less than 216 were infants, under three years of age, 27 were in the fourth year, and the remainder under twelve.

McCarthy[1] calls attention to the following pathological influences: Irritation of the skin as from excessively hot baths, scalding, and burning; sudden and violent variations in the surrounding temperature; painful wounds and foreign bodies; herpes vaginalis; phimosis; pressure on the testicles; irritation of the genitals from irritation of yarn, etc. Carious conditions of the mastoid and disease of the middle ear may be associated with convulsions without evidence of signs of meningeal trouble. Reflex conditions in the gastro-intestinal tract affect a large class of cases.

The eruption of the teeth is given as an important factor by many

[1] Osler: Modern Medicine, 1915, 2d ed., vol. v.

authorities. Ulcerative conditions of the oral mucous membrane, enlarged tonsils, and nasopharyngeal adenoids may act in a purely reflex manner, or assist in the lowering of general nutrition and nerve tone.

Overloading the stomach of a person with a finely balanced nervous system with indigestible food may be the determining factor in a convulsive seizure not only in childhood but at any period of life. The ingestion of irritating substances, such as alcohol, reacts in a like manner, as may also intestinal auto-intoxication with chronic constipation, intestinal parasites of various kinds, reflex conditions in the genito-urinary tract, catarrhal conditions, congenital anomalies, bladder and kidney stones, and congenital kidney diseases.

While given recognition in common with other reflex irritations, the full importance of pathological dentition is evidently not appreciated. Although primarily a physiological process, dentition is frequently disturbed. As it occurs at about the period of rapid brain development, which results in temporarily increased sensibility on the part of the individual, the unusual sensitiveness to irritation of the brain cells and nerve structures at this period opens the way for grave manifestations of delayed or disturbed tooth eruption. Study of the illustration on page 60 will show that the rapidly organizing mass of cells from which the tooth pulp is forming becomes daily more sensitive to pressure from the sharp borders of the calcifying tooth crowns, when the resistance of toughened overlying gum tissues makes counter-pressure against the force which would otherwise naturally crowd the erupting dental organs toward the surface. Such pressure occurring at a time of unusual individual sensitiveness must and does exert a very important influence in precipitating ill results for which there are often predisposing inherent tendencies. Many symptoms of both central and peripheral irritation which appear under these conditions may thus be accounted for.

Many infants have been relieved in the author's practice, and prompt and efficient relief has been reported by many others, or at least the way to recovery from grave infantile nervous states has been pointed out, by the simple operation of opening the toughened gum tissue covering tooth crowns. For this reason the procedure is certainly worthy of due consideration and adoption as a prophylactic, even though it may not always be a curative measure.

(For further consideration of the effect of buccal irritation see page 280.)

Chorea, St. Vitus' Dance.—This disease is manifested by irregular muscular contraction resulting in purposeless movements sometimes associated with psychic manifestations.

Etiology.—Its predisposing cause is a *neurotic tendency* represented by lack of equilibrium in the nervous inhibitory. The exciting cause may be an infectious agent or its toxin or some affection of the central nervous system. Age seems to bear an important relation

in this regard, since it most often occurs in childhood, particularly in the later years during adolescence. Osler's record of 535 cases shows that 33 occurred in the first hemidecades, 228 in the second, and 62 in the fourth.[1]

Granasso[2] says that central auto-intoxication following emotional disturbance may account for some cases.

Symptoms.—Choreic movements are spasmodic, unexpected, and although they cannot be checked by an effort of will, are likely to be increased by excitement, concentration of attention, and efforts to control the muscles involved. Such muscular twitching is generally of quick transition and does not exhaust the patient, but in rare cases it becomes so violent and continuous as to jeopardize the patient's life. Any of the muscles of the body may be involved, but those of the face and extremities are most commonly affected.

Movement of the eyelids, lips, cheeks, and tongue occurs suddenly. The facial appearance may thus be distorted into a grimace, or there may be snapping together of the jaws, grinding of the teeth, or evidences of the involvement of the respiratory and laryngeal muscles.

In a large proportion of cases the affection is unilateral and occurs upon the right side more frequently than the left. Mental irritability, as a rule, becomes noticeable early in disease. It occurs most frequently in childhood, but may appear in adult life.

Prognosis.—The prognosis is often unfavorable. Recoveries are estimated at about 5 per cent. Hopeful conditions are when treatment can be begun at a sufficiently early date by the removal of some known irritating cause or where surgical treatment is successful. Its duration is uncertain. Anemias, mental excitement, rheumatism, and endocarditis render its aspect more serious.

Treatment.—Since chorea is a symptom and not a disease *per se*, its treatment must be directed to the cause of the choreic symptoms which should be carefully sought for in every case. Every possible form of peripheral irritation or any pathological state that might have an etiological influence must be duly corrected or treated; particularly is this true of the class of cases which give evidence of etiological factors which are the subject of our special interest, such as those described in connection with convulsions, epilepsy, etc. It of course must be understood that every effort should be made to build up the general system and to favor psychic healthful influences. The administrations of medicines must be directed to the improvement of general conditions that might have predisposing influences. Fowler's solution, 3-drop doses, three times a day, increased one drop daily until a puffiness of the eyelids, nausea, or pain indicates its limit, and chloretone, 5 grains three times a day, are highly recommended remedies. The aspect of this disease which most concerns our subject is given on page 307, in connection with treatment of epilepsy and other neuroses.

[1] Copezinski: Review Neurologique, 1903, p. 1157.
[2] Riforma Medica, 1903, p. 429.

Facial Spasm.—Facial spasm is a spasmodic twitching of the muscles supplied by the facial nerve. It is a disease of adult life, and does not usually develop until after the age of forty years.

Etiology.—Sensory rather than motor irritations are believed to be its causes. Local disease of the eyelids or visual strain of the ocular muscles are held accountable in most cases for the act of winking. Irritation of the trigeminal nerve at some point or points in its distribution are the most frequent causes of the sudden contractions in the facial muscles. Therefore conditions which might lead to irritation from teeth and other parts of the mouth, nose, throat, or scalp may be active etiological factors.

Tic.—Effort has recently been made to limit the meaning of this quite broadly used term to the definition given by Brissaud and Meige:[1] "A primary act caused by an external irritation or by an idea coördinated for a special end."

Etiology.—The habit of the act is acquired by constant repetition, and then occurs involuntarily. The impulse is uncontrollable, but the act can be controlled by sufficient effort. Such habits of abnormal muscular movement are easily acquired by children who are imitative or excited by slight sensations.

Symptoms and Differential Diagnosis of Facial Spasm and Tic.—These affections have a symptomatic similarity which Patrick[2] distinguishes by calling attention to six contrasting points. Grouped in opposite columns for the sake of convenience these are as follows:

TIC.	FACIAL SPASM.
1. Tic is more common than spasm and affects nervous and neuropathic individuals.	1. More rare disposition and temperament not significant.
2. Tic is a volitional movement (even when automatic and subconscious), with extensive psychic sensory associations.	2. Is a real spasm, isolated and confined to motor innervation of the face.
3. Subject to control of the will and involuntary emotion or intellectual influence.	3. Devoid of voluntary or involuntary control.
4. Physiological.	4. Anatomical.
5. Has the appearance of natural movement.	5. Unnatural in appearance and cannot be voluntarily imitated.
6. Does not necessarily cause speech inability during spasm.	6. Speech or other physiological action is impossible.

Treatment of Facial Spasm and Tic.—The treatment of facial spasm and tic depends upon recognition of their essential differences. The relief of every possible source of peripheral irritation in the region of the involved muscles upon the one hand and control of habit upon the other.

Epilepsy.—Epilepsy is a disease or disorder afflicting the brain, characterized by recurrent paroxysms which are abrupt in appearance,

[1] Starr: Nervous and Mental Diseases, after Jour. de méd., Paris, 1905, et Chir. pract., January 24, 1894, and Traité de méd., tome x, p. 330.

[2] Jour. Nerv. and Ment. Dis., 1909.

variable in duration, but generally short, and in which there is impairment or loss of motor coördination, with or without convulsions.

Etiology.—The etiological factors which have been associated with this disease are almost without number. There is undoubtedly a primary neurotic tendency in all such patients, and in large numbers of them direct heredity is in evidence, either through epileptic parents or family history, showing insanity, alcoholism, syphilis, or other constitutional diseases. Personal history frequently shows record of spasms in infancy, difficult dentition, traumatic injuries to the head or spine, and acute infectious or other diseases of childhood. All of these are looked upon as predisposing conditions. Electrical shock, arteriosclerosis, brain disease, insanity, nephritis, disorders of menstruation, pregnancy, and maternity occasionally bear a close relation to the onset of epileptic symptoms. Affections of the heart are also frequently found in these subjects. Hydrocephalus is sometimes present in incurable cases. Under the heading of Miscellaneous Causes, Spratling sums up questions which are of vital importance from our present point of view in the following manner:

"Given a marked hereditary tendency, there are numerous agencies capable of causing epileptic convulsions in addition to those mentioned. Gastro-intestinal disorders have not received the consideration they deserve. Intestinal toxemia may cause convulsions in two ways, either by approximating the peripheral nerves (visceral) in that locality or by the absorption of certain toxic substances."

Protein poisoning and the influence of vagotonic conditions in the light of recent investigations assumes an increased importance in this relation.

Pathology.—The pathology is not clearly defined beyond certain theories with reference to organic diseases, toxemia, and the effect of well-known nerve irritations or excitants of unusual nervous activity.

Symptoms.—In a considerable number of cases the symptoms are preceded by an aura, or conscious sensation, which in time becomes a sort of warning of an attack. Detailed consideration of the many forms in which symptoms of this affection appear would be quite beyond our present purpose. All may be grouped in two chief divisions, known as *petit mal*, or slight attacks evidenced by loss of consciousness lasting for a short time and accompanied by a variety of symptoms but without actual convulsion, and *grand mal*, accompanied by loss of consciousness, a considerable period of stupor and convulsions, with loss of memory during the attack. Many of these patients show stigmata of degeneracy, as explained by Talbot and others, and have abnormal contours of the skull, peculiarly shaped ears, eyes, hands, feet, and other features. High arched palatal vaults and irregular teeth are extremely common and worthy of due consideration, and such subjects are almost invariably "tooth grinders."

Treatment.—Treatment should include careful search for and relief by proper correction of every possible form of peripheral irritation

in the jaws and mouth. Long before the onset of the characteristic symptoms in neurotic individuals, even though epileptic tendencies may not be suspected, it should be a routine practice to warn the parents of every growing child with contracted dental arches and high palatal vault, or the teeth erupting in such irregular form as to predispose to this kind of development with its inevitable ill effect in narrowing the nose and leading the intranasal deformities and diseases, that expansion particularly the upper dental arch, by separation of the maxillæ and thus widening the nose is imperatively necessary. When there is evidence of the beginning of this affection, careful search should be made for unerupted teeth, and every missing tooth properly

FIG. 157.—Radiograph of an unerupted impacted third molar, the removal of which relieved a young man, nineteen years old, of attacks of unconsciousness, with muscular twitching, preceded by an aura, and diagnosed as epilepsy.

accounted for, and if necessary its presence and situation or absence demonstrated by carefully taking radiographs (Fig. 157). The possibility of supernumerary teeth should always be borne in mind when none are missing from the regular set. Pulp stones, fillings that may cause chronic irritations of dental pulps, carious cavities, and tooth crowns which may expose their pulps to chronic irritation, the abraded occlusal surfaces of teeth which indicate tooth-grinding habits, chronic pericemental and other similar affections should be sought for with great care and properly treated if any such should be discovered.

When traumatic or other brain lesions exist, surgical treatment by location of the primarily affected area and removal of the cause if

possible, gives the only possibility of permanent relief. Even with cases so treated there i always an element of uncertainty, because it is well known that almost any operation in some subjects may cause a cessation of the attacks for considerable periods of time, though no real permanent good may have been accomplished.

Fenestration of the Skull.—The removal of intracranial pressure by this and similar expedients is a procedure that is undoubtedly growing in favor among surgeons for the relief of affections of various kinds, and in certain forms of epilepsy might be expected to afford unusual relief.

Other treatment in a general way includes building up the strength and normal vital energy of the patient by good hygienic care, dietetic regulations, and favorable psychic influences, baths, massage, daily flushing of the bowels, appropriate treatment for improvement of intestinal conditions, and the administration of bromides, which should be given in large doses.

It is claimed by Prior and Jones[1] that there is a diminished amount of free calcium in the blood of epileptics, and that they may be benefited by the administration of calcium. Wherry and Oliver[2] recommend the administration of calcium combined with bromides.

With reference to all of the spasmodic affections such as infantile spasm, chorea, epilepsy, and similar diseases, the purpose of giving them consideration in this volume is to emphasize the features which are properly connected with the effect and relief of dental and oral irritation. Therefore no attempt at detailed description of the many methods of treatment of these is undertaken.

The Relations of the Mouth and Teeth to Spasmodic Neuroses.—It is a significant fact that the onset of the symptoms of chorea, epilepsy, and kindred affections in the great majority of cases occurs at periods of development termed by Talbot "Periods of Stress." Kierman pointed out that they are coincident with the development and eruption of both temporary and permanent sets of teeth, particularly at about the age of five or six years, when the first permanent molar is erupted. He showed that in persons of unstable nervous system their neurotic tendencies predispose to these affections. Irritation from pressure of the sharp borders of the undeveloped open ends of the growing roots against the underlying nerve structures is caused by resistance of overlying structures in the process of tooth eruption as previously described (page 59), or by the crowding of malposed teeth in contracted dental arches. On account of the bell-shape of the tooth crowns and the conical form of the roots there results a slight nerve stretching when the force of the jaws is applied upon these crowded teeth. Thus a more or less continuous nerve irritation arises, which at this time of weakened resistance intensifies already existing tenden-

[1] Med. Jour., Australia, March 4, 1916, and Practical Medicine Series, page 19, Nervous and Mental Diseases.

[2] Jour. Am. Med. Assn., October 7, 1916.

cies and precipitates attacks of these affections. Kiernan also expresses the belief that if such persons could be guarded from irritation of this character at such periods, choreic and epileptic attacks would be avoided in many instances, for with increased age and natural correction of the irritation the tendency would probably disappear and disorders of that character not be manifested.

Spratling[1] states: "Difficult dentition probably never acts as an unqualified cause when not influenced by another agency, but there is little doubt that when dentition becomes pathological in a strongly tainted neuropathic subject it may cause a type of convulsion which, if permitted to go unchecked, may evidently pass into a more or less true form of the disease. No one would think of designating as epilepsy a single convulsion caused by painful dentition in a rachitic child, accompanied by high temperature, irritability, and great restlessness. But should there be several convulsions which continue with more or less regularity, showing the essential characteristics of the true disease, including the aura, the epileptic cry, and the various postconclusive phenomena, common reason would lead us to designate them as epileptic. So while dentition may never be an unqualified factor, it has under special conditions the power to incite a type of convulsion that may pass into epilepsy so far as the general results, by prognosis, and the treatment are considered. In 30 cases the palsy originating between the sixth and eleventh month of life, and all persons known to the writer, difficult dentition was the assigned cause."

In this connection it should be borne in mind that delayed tooth eruption, particularly the third molars, may occur and be a source of serious irritation at later periods of life. One of the author's patients, a young lady, aged twenty-six years, suffered from intense and more or less continuous pain at various points of distribution of the fifth nerve on the left side, accompanied by choreic movement of the muscles of the arm and leg upon the affected side, with occasional manifestations in the facial region. It was found that the crown of the left superior third molar was crowded between the roots of the second molar upon the same side, and the left lower third molar was so impacted as to cause continued crowding of the lower teeth. The removal of these teeth gave a measure of relief, although the long continuance of the symptoms before this cause was discovered had undoubtedly led to general involvement which made immediate cure impossible.

Such conditions are very common causes of nervous disturbance. Large numbers of the author's patients with varying symptoms of neurasthenia, chronic neuralgia of the head and face, and other neuroses have been relieved or completely cured by the discovery and removal of malposed or impacted teeth delayed in their eruption. (For further references see pages 60 to 65.)

[1] Osler: Modern Medicine, 1915, 2d ed., vol. v.

A case of Jacksonian epilepsy in a man, aged twenty-two years, is an example of the effect of surgical maxillary separation in certain epileptics.

History.—Nervous troubles began in 1904. The seizures started with spasmodic contractions, or numbness, sometimes partial or complete unconsciousness. The symptoms usually began in the right foot and ascended to the head, and across the forehead, but only in the more profound attacks was the left side involved. An extract from the records of St. Mary's Hospital shows the frequency of these attacks at the time of his entrance, during one day and one night. The record for every day and night was practically the same:

RECORD.

7.10 A.M. Slight spell lasting thirty seconds. Muscular twitching of left arm and eyes. Sleeping.
7.20 A.M. Slight spell lasting twenty seconds.
7.30 A.M. Twitching of left side.
7.45 A.M. Slight spell lasting fifteen seconds. Twitching of left limb and arm.
8.00 A.M. Slight spell lasting twenty seconds. Twitching of left arm.
8.05 A.M. Slight spell lasting twenty seconds. Twitching of left and right limb.
8.30 A.M. Slight spell lasting thirty seconds. Muscular twitching of eyes and left side.
8.50 A.M. Severe spell lasting forty seconds. Twitching of muscles.
8.54 A.M. Slight spell lasting twenty seconds. Muscular twitching of left limbs.
8.57 A.M. Slight spell lasting twenty seconds. Muscular twitching of face.
9.10 A.M. Slight spell lasting ten seconds. Twitching of feet.
9.20 A.M. Slight spell lasting thirty seconds. Twitching of left limbs.
9.30 A.M. Slight spell lasting forty seconds. Muscular twitching of eyes and left arm.
9.45 A.M. Slight spell lasting fifteen seconds. Muscular twitching of feet and left arm.
9.55 A.M. Slight spell lasting thirty seconds. Twitching of left limbs.
10.00 A.M. Slight spell lasting five seconds. Twitching of left hand.
10.07 A.M. Slight spell lasting forty seconds. Muscular twitching of feet and eyes.
10.10 A.M. Slight spell lasting twenty seconds. Twitching of left limbs.
10.15 A.M. Slight spell lasting fifteen seconds. Throwing left foot from body.

10.20 A.M. Slight spell lasting twenty seconds. Twitching of left limbs.
10.30 A.M. Slight spell lasting ten seconds. Twitching of limbs.
10.34 A.M. Slight spell lasting thirty seconds. Muscular twitching of eyes.
10.43 A.M. Severe spell lasting fifty seconds. Muscular twitching of limbs, tossing about, cough at intervals.
10.50 A.M. Slight spell lasting thirty seconds. Twitching of left limbs, pulling at clothing.
11.00 A.M. Slight spell lasting ten seconds. Twitching of eyes.
11.10 A.M. Slight spell lasting twenty seconds. Twitching of limbs.
11.20 A.M. Slight spell lasting five seconds. Twitching of eyes.
11.30 A.M. Slight spell lasting thirty seconds. Twitching of limbs.

This record is typical of his other days up to the time of the operation. His maxillary bones were separated through an incision under the upper lip. A wide separation was immediately effected, and pressure with the appliance continued by tightening the nut for several days, until he said it felt like a gale of wind through his nose when he breathed. Following the operation diplopia was noted. The double vision soon disappeared and in the course of three or four days the attacks began to be less frequent, and had ceased altogether by the ninth day, when he was discharged from the hospital.

FIG. 158.—An epileptic young woman who seems to have been entirely relieved by this surgical immediate separation of the maxillæ. Shows a type of face that indicates the need of this treatment.

He was quite free from further trouble, grew strong and well and increased in flesh, for a period of about two years. At this time it was learned that he had had more or less recurrence of the attacks. As he

has not reported, the author is unable to state the character or duration of the relapse.

The expression of his eyes and his whole appearance changed, as the effect of the improved respiratory condition became apparent.

All cases that have been treated in this way, thus far, have evidenced improvement, but some have not been completely relieved for any considerable period of time.

The young women shown in Fig. 158 is at the present time and for several weeks has been free from epileptic seizures, which up to the time of surgical maxillary separation for intranasal enlargement had gradually been becoming more frequent and serious in their character. It seems unnecessary to make an attempt to report these and other cases in detail, for this brief reference is only intended to call attention to the possibilities of intelligent oral treatment as a helpful measure for the relief of at least some of the sufferers from epilepsy and similar affections, but not in any sense as a sovereign remedy. When indicated by high narrow palates, contracted dental arches, and nasal conditions which favor the habit of mouth-breathing, this should be a routine measure in all cases of epilepsy to prepare for and increase the efficiency of any other treatment that may be given.

Bacillus Epilepticus.—Dr. C. A. L. Reed,[1] of Cincinnati, claims to have discovered that the cause of epilepsy is a bacillus which he has isolated and named the "Bacillus epilepticus."

Terhune reports that the Bacillus epilepticus has been isolated from 75 per cent. of 24 of the cases of epileptics, from which cultures were made during, or immediately following seizures, and 18 in whom no convulsions had occurred for several days. Wherry, Oliver, Canavan, and other investigators have failed to identify this bacillus, and its etiological identity with epilepsy is not yet generally accepted. Reed has also reported a large number of cases in which he believes a cure has been effected by operations to overcome colonic stasis.

HYSTERIA.

Hysteria is a neurosis characterized by abnormal cessations, a morbid susceptibility to emotions, and inability to restrain their manifestations.

Etiology.—Hysteria plays a part in nervous affections of the mouth and associated parts, as in other regions of the organism as a whole. Its extended consideration would be outside the province of this work, except insofar as general conclusions may be indicated to avoid error in diagnosis and treatment.

Symptoms.—Babinski[2] states that the reason for the excessive extension of the symptomatology of hysteria is due to three leading

[1] Practical Medicine Series, Nerv. and Ment. Dis., 1916, p. 19.

[2] La Semaine Médicale, January 6, 1909. Babinski's articles on the Dismemberment of Traditional Hysteria Pithiatism, published in La Semaine Médicale, as the first paper in 1909, translated by Charles Gilbert Chaddock, and published in the Interstate Medical Journal, March, 1909.

causes; (1) Errors of diagnosis, many organic cases being considered hysterical; (2) failure to detect simulation; (3) failure to distinguish various nervous states which ought to be distinguished one from another.

He differentiates between two great groups of symptoms, as (1) those which can be produced by suggestion, and (2) those which cannot be so produced.

Symptoms which may be produced by suggestion, and are therefore hysterical, are: Convulsive crises, paralysis, contractures of every sort and location, various tremors, choreic movements, disturbances of phonation and of respiration, sensory disturbances such as anesthesia and hyperesthesia. Symptoms not capable of being produced by suggestion, and therefore not hysterical, are: Exaggeration or loss of the tendon reflexes, vasometer, secretory, and trophic changes, hemorrhage, anuria, albuminuria, and fever.

Diagnosis.—It is sometimes very difficult to determine whether pain in the teeth or other points of distribution of the fifth nerve, spasmodic affections of the muscles and other similar disturbances in the region of the mouth are wholly or even partially of hysterical origin or their apparent gravity exhibited from the same cause. Too often real though hidden pathological conditions are overlooked, and through imperfect diagnoses there is failure to give relief, and much consequent suffering because the symptoms have been erroneously pronounced imaginary after superficial examination.

On the other hand, it has not infrequently occurred that teeth have been needlessly extracted, pulps of teeth removed, useful fillings or other dental work destroyed, and no local real pathological conditions of the parts so treated. No set rule for the avoidance of such errors can be given, and the operator must necessarily rely upon his own knowledge and skill as a diagnostician to determine indications of actual disease, supplemented by good judgment in determining the mental attitude of each patient. With the foregoing division of affections that might or might not be evidence of hysteria as a guide, differentiation will be much simplified.

NEURASTHENIA.

Neurasthenia may be defined as debility or impaired activity of the nerves or of the nervous system generally, nerve causation.

Etiology.—The leading causes of neurasthenia summed up according to Schofield,[1] who is in accordance with other writers, are:

1. Poisons from influenza, syphilis, enteritis, dyspepsia, alcohol, drugs, zymotic and other diseases.
2. Malnutrition.
3. Fatigue from overwork, worry, insomnia, pain, sexual excesses, suppression.

[1] British Med. Jour., September 19, 1908; Practical Medicine Series, 1909, x, 31.

4. Emotional strain from shock, grief, accidents, religion, love, etc.
5. Indirect causes, as enteroptosis, floating kidney, eye-strain, also bad environment, suggestion, and other psychic factors.

The principal predisposing cause is hereditary. Psychologically neurasthenia is a disease of exhaustion of the higher nerve centers, since poisoning produces toxic effects similar to those from overwork. To weakness of these centers by fatigue or poison from some of the above causes we may attribute even the most psychical symptoms of this disease, such as "phobias" and "obsession," provided always that the patient be free from any underlying mental taint.

To these should be added, for our special purpose, conditions of the mouth which can, and do in many instances, predispose or directly or indirectly contribute to any or all of the foregoing etiological influences.

It is well known that there is no more common factor associated with the cause of stomach and intestinal disturbances and malnutrition than diseased, uncleanly, or defective teeth. The question of food trituration in mastication and its proper insalivation from active proper use of the jaws, the necessity of sufficiency or insufficiency of ptyalin from the saliva for assistance in the digestion of starch foods, and the effect of all these combined influences upon metabolism are so obvious as to make elaborate discussion unnecessary. The same may be said of bacterial influences, exerted by pathogenic microorganisms from uncleanly, decaying, or diseased tooth roots, gums, and other structures being carried through the intestinal tract and focal infection *via* other channels. It is also well understood that there is no more active or constant poison in general disease than the autotoxemia which goes hand in hand with these conditions. The question of fatigue, however, requires distinct consideration on account of the fact that tooth grinding, especially at night, is an almost constant symptom of general nervous states and particularly neurasthenia. On account of the teeth being crowded in the dental arch, imperfect occlusion through loss of teeth, malposition, or other conditions that may tend to produce irritation, the habit of clinching and grinding teeth is induced. Patients are seldom ready to admit the fact until absolutely proved, because the habit is an unconscious one, active at subconscious moments in the daytime, but more particularly at night during sleep, which is therefore not sufficiently restful. The constant exertion of the muscles of mastication with the incident brain cell stimulation prevents perfect rest, which in the course of time may undoubtedly lead to quite as grave conditions as eye-strain or any of the other similar factors which are much better understood and in consequence more often recognized in diagnosis. The jaws teeth, and other structures or tissues connected therewith, as well as the contents of the mouth and its use, including hygienic care and habits which concern conscious or unconscious use, are inevitably matters of importance in considering causative factors and bear an

important relation to all divisions of the foregoing etiological classification. To say that these oral influences are the most important causes would be rediculous in the face of broader knowledge of contributing affections. It has been, however, a matter of frequent occurrence in the author's clinical experience that the correction, treatment, and care of the teeth and mouth for relief of patients suffering from neurasthenia have been efficient in setting them on the road to recovery. The results have been so satisfactory in helping build up resistance against other pathogenic influences that in this light the subject warrants the fullest possible attention under every circumstance.

ANGIONEUROTIC EDEMA.

Angioneurotic edema is a transient edematous swelling affecting limited portions of the surface of the body.

FIG. 159.—Condition, in 1889, before enlargement of head and neck began. (Starr.)

Etiology.—The cause is not fully understood. Exposure to cold seems to have an effective immediate influence. Osler recognizes an hereditary influence.

Pathology.—The pathology is not known.

Symptoms.—The symptoms may affect any part of the body, but usually appear in the face and extremities. There is swelling, which may come and go quickly or continue for several days. Color may vary from red to whitish yellow or pale. There is stiffness and numbness of the part.

Treatment.—The treatment is not well understood, but massage and strychnin are recommended. Most of the cases reported have been those in which the symptoms were quite marked, but a slight transient edema of the face quite unaccompanied by any inflammatory symp-

toms is frequently noticed in patients suffering from tic douloureux and other affections due to irritation of the trigeminal nerve. Although no claim is made that these are identical with angioneurotic edema, yet in the absence of full etiological and pathological knowledge there is at least sufficient similarity to warrant careful search of the teeth and mouth for possible chronic irritations of dental pulps, malposed impacted teeth, and other similar factors that might be aggravating influences. The immediate correction of any such condition is certainly indicated.

FIG. 160.—Condition, in 1894, showing uniform enlargement of the head. (Starr.)

TROPHIC CHANGES.

Trophic changes as evidenced by *atrophy* due to nervous causes is well understood. *Hypertrophy* that can only be satisfactorily accounted for a neurosis occurs occasionally. Starr accounts for the marked increase in the size of the head and face shown in Figs. 159 and 160 as due to one of the trophic neuroses. These are of interest to our subject because of the region affected. There may also be alterations affecting the hair, face, and lips of similar origin.

PROGRESSIVE LIPODYSTROPHY.

Progressive lipodystrophy, a condition in which there is progressive disappearance of adipose tissue of the face, upper chest, and arms. There are no symptoms except loss of subcutaneous fat of the affected parts, with increase of adipose tissue in the lower parts of the body. The condition is very rare, approximately 16 cases on record. Enlargement of the thyroid indicates excessive thyroid functioning. The cause of this affection is not definitely known.

CHAPTER VI.

DISEASES OF BONE.

Among the elements pertaining to processes of bone development, consideration of which belongs more properly to the text-books on Histology and Embryology, there are some which have such an important bearing upon morbid processes affecting bones of the face and jaws in common with other osseous structures that they deserve brief consideration.

Osteogenesis.—In growing bone while absorption is taking place in the interior of the bone, through the agency of the *osteoclasts*, additional bone is formed by the *osteoblasts* upon the external surface from the generic layer of the periosteum. This is called *osseous apposition*.

Osseous Resorption.—Bone absorption takes place through the action of nucleated masses of protoplasm directly acting upon the calcified matrix, to form small cavities, called Howslip's lacunæ. Osteoclasts are the cells which accomplish this result. Lacunar absorption is not only important in physiological processes, but is frequently concerned in the pathology of atrophic bone absorption.

Atrophy of Bone.—Atrophy of bone may be *eccentric* when it progressses from within outward, *concentric* when it begins immediately under the periosteum and progresses inward with tendency to lessen the circumference of the bone.

The processes by which bone absorption takes place are:

Lacunar Absorption.—Described above.

Perforating Canal Absorption.—This consists in the penetration of new formed bloodvessels through the lamella which communicate with the Haversian canals and increase the area of excavation along these channels, thus leading to *osteoporosis*.

Halisteresis.—This consists in the removal of lime salts, with subsequent changes in the osseous matrix. There is some question whether this is a true atrophic process, but is usually so considered and may be

Local.—In connection with some pathological process; or,

General.—As an evidence of constitutional conditions, and is then called osteomalacia.

Osteomalacia.—Osteomalacia is characterized by absorption of the bone salts with other changes in the bone that cause extreme flexibility and is probably a form of trophic neurosis, although its exact cause is not definitely understood. It is frequently found in puerperal women, and may be accompanied by distortions, bends, and even fractures of bones.

Regeneration of Bone.—Regeneration of bone occurs when fracture or loss of bone structure takes place through injury or disease. As a result of irritation, proliferative changes take place, new bloodvessels are formed, and the tissue becomes hardened from deposit of calcareous matter and cartilaginous formation. Gradually bone is formed through the renewed activity of bone-forming processes thus excited.

In recent years much discussion has taken place, and quite opposite opinions have been expressed, concerning the osteogenetic activities of the periosteum. To one accustomed to plastic operations, involving the transposition of periosteal structures, it is not surprising that one experimenter will find that the periosteum is incapable of bone formation when unassisted by other influences, and another will report, quite as positively, that the preservation of the periosteum is important for bone regeneration following operative procedures. Undoubtedly the personal equation is an important, often a deciding, influence in determining such experimental results. Personally, the author has no doubt of the osteogenetic functions when the periosteum is preserved intact, and uninjured, in its natural situation. Evidences of this may be seen on pages 440 and 467. The testimony of successful bone grafts may also be adduced to prove this contension. Quite naturally it is the combination of periosteum with extension of bone growth from fractured or divided bone ends that is required, and such combination should be contemplated in designing surgical procedures.

Pressure Atrophy.—Pressure atrophy occurs from constantly applied pressure. This may be mechanical or due to tumors, aneurysms, the accumulation of fluid in cavities surrounded by bone, as in the air sinuses of the face, abscess, cysts, and similar conditions. It is upon this principle that the effectiveness of orthopedic and orthodontic appliances depends.

Surgically, questions of bone formation, resorption, and regeneration are of great importance as affecting restoration of bone when destroyed by disease or surgically removed; the possibility of bone formation taking place from periosteum that has been left intact after the removal of sequestra of necrosed bone, and the renewed activity of osteoblasts in persons of advanced years, or who have passed the period of normal bone growth; in repair of fractures and reconstruction following operations. Such questions also constantly arise in connection with bone absorption incident to the movement of teeth in orthodontic treatment and in operations for cleft-palate, particularly as related to the results from mucoperiosteal flaps.

Malformations of Bone.—Etiology.—The many perversions of osseous development, which are usually evidenced by defective or perverted bone formation, may be due to *general disease, inherent tendency, achondroplasia, i. e.,* defect in the laying down of primary enchondrial matrix from which most of the bones of the skeleton are formed, and in which such defects are later evidenced, *arrested development, affections of the central nervous system, traumatic injuries, abnormal muscular*

action as influencing perversion of form, *imperfect metabolism*, *rachitis* (rickets), and other causes which are more specifically described in chapters relating to deformities.

Agenesis.—*Entire failure of development* may be restricted to one bone, a part of a bone, or the entire skeleton, as in microsomia, nanosomia, the terms used to describe dwarfs.

Changes in bone marrow result from systematic conditions and from local disease; usually this is a marked feature in pernicious anemia, acute leukemia, and acute infections.

Osteogenesis Imperfecta.—Congenital insufficiency of the bone-building elements results in a condition of osseous structure which is in effect much like osteomalacia. Such children are usually very small at birth, with evidence of more or less imperfection of general form. The bones are extremely fragile and fracture easily. Not infrequently there is mental defect also.

RICKETS, RACHITIS, RACHITISMUS, MORBUS ANGLICUS.

Rickets.—Rickets is a constitutional disorder characterized by abnormal development of the bones and other structures with lack of normal calcification.

Etiology.—The etiology is not fully understood. It is believed to be a disorder of nutrition during the period of active growth.

Pathology.—Osteoporosis results from lacunar absorption. Osteophytes are formed from unusual periosteal activity. There is abundant production of osteoid matrix penetrated by medullary vessels, but there is a lack of normal deposits of bone. Ligamentous attachments of bone are imperfect, there is deficient muscular development as well as pathological abnormalities of the internal organs, with catarrhal affections of the mucosa.

Prognosis.—Prognosis depends upon the possibility of inducing natural or forced improvement; the developmental processes before prognosis of the disease has rendered such improvement possible.

Treatment.—Treatment should be governed by such measures as may tend to improve nutrition and facilitate normal general development. There should be a nourishing diet, which should include fats and nourishing oils in such quantities as may be properly assimilated. Cod-liver oil and phosphorus may be beneficial, baths, massage, open-air exercise, and generally healthful condition must be insured, and supplemented by proper support and correction of osseous deformities. In these cases there is usually more or less marked abnormality in development of the teeth and jaws. Proper regulation of these conditions offers favorable opportunity for rendering assistance to these patients, both directly and indirectly.

Hypertrophy of Bone.—Hypertrophy of bone may be local or general.

Local Hypertrophy.—*Etiology.*—Increased or unusual development of muscles sometimes causes ridges and thickening of the bone surface to which the muscles are attached. Chronic irritation of the periosteum may also cause increase of bone structure.

Symptoms.—The symptoms are ridges or excrescences upon bone surfaces, abnormal thickness or giant growth which may affect certain bones or part of the skeleton. In children this is usually noted in the upper extremities.

General Hypertrophy.—Gigantism, general hypertrophy, or complete giant growth is usually first noted about the age of puberty. The bones become large, thickened, and irregular, and the individual sometimes attains an enormous size.

Acromegaly.—This disease is characterized by giant growth which affects both flat and long bones, but is most frequently noticeable in the face, particularly the lower jaws and nose, the hands and feet, forearms and legs. It is accompanied by more or less hyperplasia of the soft tissues in the affected regions.

Etiology.—That there is some etiological relationship between gigantism and acromegaly as well as leontiasis ossea and hemihypertrophy of the face is generally conceded, although not fully understood. The most commonly accepted theory at the present time is that it results from some pathological condition of the hypophysis cerebri and enlargement of the sella turcica found in the skeletons of giants has been accepted as evidence of the enlargement of the pituitary body. Cushing, Sajous and others have gathered evidence to prove that there is a direct relationship between pituitary disease and bone hypertrophies.

Symptoms.—The lower jaw increases in length and thickness, becomes swollen, prognathous, and may project much beyond the upper. This together with growth in the length and thickness of condyles sometimes renders occlusion of the teeth impossible. The nose becomes thick and broad, the lips thick and protruding, the facial sinuses much enlarged, with more or less bulging in this region. The hands and feet become enormously large and thick. Similar changes may take place in the pelvic bones, the sternum, ribs, and in the spine, which with a drooping forward of the head and the prognathous lower jaw give an ape-like deformity (Fig. 161).

Prognosis.—As there is no exact knowledge of the cause, and treatment is uncertain, the prognosis must necessarily be grave. The progress of this disease, however, is often very slow and does not directly shorten the period of life.

Treatment.—Aside from such operative procedure as in rare instances may be required to overcome the inconvenience and ill effect of the deformity, especially to make possible the use of the jaws in mastication, the only hopeful treatment seems to lie in the administration of pituitary extract, with rest, change of occupation, and such supplementary measures as may tend to restore general nervous balance.

Cushing has suggested and reported good results from operations for removal of pathological processes which may effect the gland.

One case of a man past middle life was referred to the author for operation to make closure of the jaws possible. All the typical symptoms of this affection were present in very marked degree, but further progress of the unwelcome growth had already been checked, presum-

Fig. 161.—Acromegaly. (Park.)

ably by long-continued treatment with pituitary extract, and the mechanical difficulty of occlusion had been so well overcome by ingenious dental work performed by Dr. Robin Adair, of Atlanta, Georgia, that it seemed unnecessary to incur the risk and uncertainty of operation upon the jaws. (See Fig. 162.)

Hemihypertrophy of the Face.—This condition, in which the bones of the face become enlarged upon one side, is presumably closely allied to acromegaly, although its true character is not fully understood.

Leontiasis Ossea.—This form of bony growth affects with more or less symmetrical enlargement the facial bones upon both sides, particu-

larly the upper part of the face, and has received its name on account of the lion-like appearance of the countenance.

Etiology.—Etiologically there seems to be every reason to believe that all of these affections are closely allied, but definite knowledge is lacking.

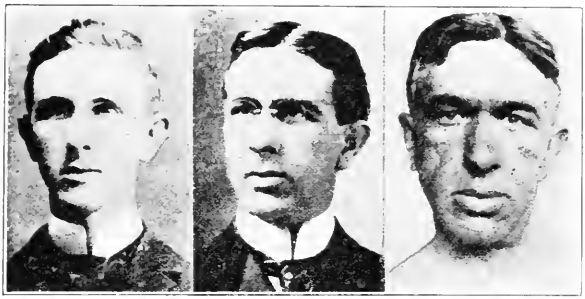


FIG. 162.—This patient had formerly been under the care of Dr. Cushing at Baltimore, and it is from his work on the pituitary body that these pictures were taken. Patient before the onset of the malady (aged eighteen); at the time of the onset (aged twenty-six); after its full development (aged forty).

Symptoms.—In the course of development of hypertrophied bone, it may restrict the size of the orbits, the nasal passages, or foramina, and by compression of enclosed structures, especially when nerve trunks are involved, give rise to painful or other symptoms of nervous disturbance (Fig. 163).

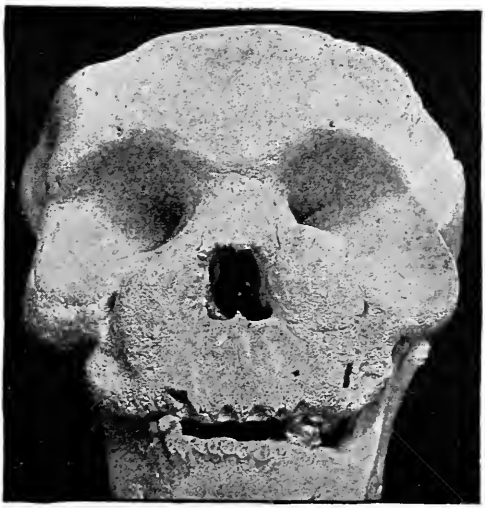


FIG. 163.—Leontiasis. Skull of a Chinese woman. (U. S. A. Museum, No. 10,620.)

Treatment.—Surgical treatment is practically unavailing, because removal of portions of the hypertrophied bone only gives temporary relief and the deformity quickly returns.

Ostitis Deformans.—Ostitis deformans is a disease of middle life or later, manifested by thickening of the skull and long bones, marked softening and loss of resistance to pressure.

Etiology.—Its etiological character is unknown. There is a difference of opinion as to whether it is a result of an inflammatory cause, trophic disturbance, or syphilis.

Pathology.—The compact bone becomes absorbed with confluence of the Haversian canals, and there is new formation of uncalcified osseous tissue with accompanying alteration in form.

Symptoms.—The symptoms include broadening of the cranium, curvatures of the long bones, pain and discomfort in the affected region.

Treatment.—Until its character is better understood its treatment must necessarily be only for the relief of such general pathological states as might be recognized as interfering with bone nutrition, and good hygienic care is, of course, always indicated.

The removal of all focal infection in such cases should not be overlooked.

DISEASES OF THE PERIOSTEUM.

Hemorrhage under the Periosteum.— Etiology.—This condition may be caused by scurvy and other blood diseases, trauma, or infectious diseases.

Pathology.—The formation of a blood clot under the periosteum destroys its attachment from the bone over a more or less extensive area. If infected, there may be suppuration, necrosis, and the results which follow in sequence from these conditions.

Prognosis and Treatment.—When absorption in natural course is sufficient to remove the blood the symptoms subside without treatment, but if this does not occur spontaneously then treatment is required to be directed toward overcoming the disease acting as an underlying cause, or to cure pathological results as described in consideration of periostitis.

Periostitis.—Inflammation of the periosteum may be acute or chronic. Its forms are *simple* or *non-infective, suppurative,* and *ossifying,* or *osteoperiostitis.*

Acute Simple Periostitis.—*Etiology.*—This form is due to trifling or traumatic injuries to the periosteum without infection.

Pathology.—The periosteum becomes swollen and may be separated from the underlying bone by subperiosteal hemorrhage. This is quickly followed by absorption of the blood, proliferation of connective tissue, and more or less leukocytic infiltration. Through the activity of the phagocytes the blood is removed, the cellular products of the inflammatory condition may result in the formation of cicatricial tissue which may become calcified or form bone by the assistance of the osteoblasts.

Symptoms.—Pain, tenderness to pressure, and sometimes hemorrhage under the periosteum, which causes more or less separation from the bone, are prominent symptoms.

Prognosis.—The prognosis is good, except when infection takes place.

Treatment.—Usually little assistance is required to hasten recovery. Hot fomentations and occasionally, in the more troublesome cases with extensive hemorrhage under the periosteum, incision through the overlying tissues down to the bone surface, to be followed by suitable antiseptic dressings.

Purulent Periostitis.—Periostitis due to infection by microörganisms may be *circumscribed,* confined to a small area, or *diffuse,* when the suppurative process tends to spread over the bone surface and separate the periosteal attachments over a more or less considerable area.

Etiology.—Suppurative periostitis is associated with both ostitis and osteomyelitis, being sometimes a cause and sometimes a result of these diseases. Its etiological factors are therefore identical with those enumerated in description of these affections of bone (see p. 326).

Pathology.—There is more or less marked swelling and cellular infiltration with pus formation which tends to separate the periosteum and bone. If sufficient to interfere with circulation and nourishment over an extended area of bone surface superficial necrosis with exfoliation results.

Treatment.—The treatment of purulent periostitis requires removal or treatment of the cause, relief of the pus by incision down to the bone under antiseptic precaution, and cleansing of the wound, preferably with tincture of iodin. The application of hot gauze wrung out in boric acid solution, 1 to 1000 bichloride of mercury or other suitable antiseptic, which may be required to check if possible both the danger of more general infection and local destruction of the underlying bone.

Osteoperiostitis.—Osteoperiostitis may result from long-continued, not too severe chronic irritation and from constitutional diseases, notably syphilis.

Pathology.—A proliferation of the osteogenetic layer of the periosteum takes place, the partial ossification, and finally complete bone formation with attachment to the underlying bone, results in the form of excrescences, exostoses, or osteophytes.

Treatment.—Treatment consists in removal of the cause and when required removal of the superfluous bone. These growths are frequently noticeable in the maxillæ, sometimes along the central division of the palate. Occasionally there are enlargements of the buccal side and posterior to the tuberosities and at other points in the neighborhood of the roots of teeth. Usually they are unattended by disturbing symptoms. Occasionally the bone growth interferes with some other parts, and its removal is required.

INFLAMMATION OF BONE.

Inflammation of bone is recognized in two principal forms. These are *osteitis* or *ostitis*, inflammation of the compact portion of the bone, and *osteomyelitis*, inflammation originating in or extending to the medullary structures.

Clinically it is practically impossible to differentiate between these two forms of bone inflammation because almost invariably one leads to the other.

Osteomyelitis.—Osteomyelitis is an infective disease involving at first the bone marrow and central or cellular parts of the bone.

Etiology.—Its causes are pyogenic microörganisms following traumatic injury, suppurative forms of periostitis, infection through the circulation, infective diseases, dento-alveolar abscess, fracture and toxic effects from mineral or other poisons. Quite frequently it has been found to be the result of infection from the pneumococcus, Bacillus typhosus, Bacillus coli communis, tubercle bacilli, and other microörganisms.

Pathology.—Cellular infiltration and proliferation accompany changes in the bone marrow. Vascular distention is associated with thrombosis, which is followed by coagulation necrosis, liquefaction of intercellular substance and the development of purulent foci. Coalescence of these tiny abscesses leads to rapid destruction of bone. Dead bone is thrown off in the form of a sequestrum, and suppurative periostitis conveys the infection to the overlying tissues with resulting inflammation and the formation of a sinus for the discharge of pus.

Symptoms and Treatment.—See Necrosis.

NECROSIS OF THE JAWS.

Necrosis and caries of bone are sequelæ of bone inflammation, and since it is these conditions of the maxillary bones that most frequently require treatment, the acute, subacute, and chronic forms of both, ostitis and osteomyelitis, as well as the symptoms and treatment of these associated conditions, will be considered together in their relation to necrosis for purposes of simplification and clinical directness.

Necrosis and Caries.—Necrosis is death of bone *en masse*. Technically any dead tissue is necrotic, but the term necrosis is usually applied to distinguish from a slough, gangrene, or death *en masse* of soft tissue. Caries is molecular destruction of bone. A similar condition affecting the soft tissues is called an ulcer.

Etiology.—Acute or chronic diseases of the periosteum, bone marrow, and adjacent bone, and interference with blood supply by separation from the underlying bone in purulent periostitis are the direct causes of necrosis.

The factors to which these conditions are due have already been described as injury, infection by pathogenic microörganisms, including staphylococci and other bacterial forms recognized as representative of general disease and the toxic effects of certain mineral and other poisons, which are also capable of producing the practically inseparable chain of conditions associated with bone inflammation. Some of these causes require individual recognition and special treatment in order to secure successful results from local treatment of the diseased bone.

The classification of etiological factors on page 328 is presented as arranged for clinical convenience and assistance.

There are some peculiarities of necrosis of jaws the importance of which has been impressed upon the author by a long series of cases in which very disastrous results might have been averted by early recognition of the cause. In some of these, as will be noted, the process of bone destruction continued for fifteen years and more, with widely distributed ill results through constant absorption of toxic products by the general system. The following cases are typical forms of necrosis of the jaws, therefore each has an important significance.

Case I.—This was a child, aged five years, with history of trouble with pain, which began many months before coming under the author's care. There were swelling and soreness of the mouth in the region of the premolar teeth, high temperature, malaise, and a slight eruption upon the skin. Her physician diagnosticated typhoid fever; later the disease was termed some other form of fever. Upon examination it was found that large sequestra of bone representing the major portion of both upper and lower jaws were in a state of exfoliation, and so completely had Nature performed her office in this respect that upon removal of the dead pieces of bone newly granulated surfaces beneath them were found to be perfectly healthy and the child discharged from the hospital as practically cured the day following the operation.

Case II.—This was the case of a young boy, Harry D., aged seven years. Trouble began with toothache, which lasted for six months. After extraction of tooth, swelling began in the face. The symptoms were fistula with pus discharge at extreme angle just below right eye. Depression was marked in that region and the lower eyelid was everted. There had been one or two operations performed, and his surgeon finally advised the parents to wait until all of the dead bone might be forced out through the fistula just at the outer angle of the eye. At this point several pieces had been removed. It was found that almost the entire upper maxilla upon the affected side was necrosed. By carefully removing each loosened piece of bone without disturbing underlying structures it was possible to leave the molar teeth in course of eruption partly embedded in healthful bone structure. Later development proved that new bone was formed about these teeth and in that way serious deformity was avoided.

- **Diseases of the teeth and alveolar structures**
  - Dento-alveolar abscess
    - Devitalized or infected, or Gangrenous tooth pulps.
    - Imperfectly filled roots of teeth.
    - Fractured roots of teeth.
    - Implantation, transplantation, and replantation of roots of teeth.
  - Chronic pericementitis.
  - Pyorrhea alveolaris.
  - Pericemental abscess.
  - Ulcerative stomatitis.
  - Gangrenous stomatitis.
  - Gangrenous conditions of the buccal tissues.
  - Traumatism
    - Injury to the periosteum with subsequent infection.
    - Compound fractures of the jaw or of teeth, or dislocation of roots of teeth.
    - External blows, or force causing the jaws to strike forcibly together, causing subsequent death and infection of and from tooth pulps.
- Foreign bodies in the tissues.
- Extension of nasal disease.
- Empyema of the maxillary sinus.
- Middle-ear disease, furuncle or other inflammatory affections of the skin and soft tissues of the face.
- Surgical operations upon the maxillary bones.
- **Infectious diseases**
  - Exanthemata or eruptive fevers
    - Typhoid fever.
    - Scarlet fever.
    - Measles.
    - Smallpox.
  - Influenza (la grippe).
  - Tuberculosis.
  - Syphilis.
  - Actinomycosis.
  - Glanders.
  - Leprosy.
- **Blood disorders**
  - Predisposing conditions
    - Anemia.
    - Chlorosis.
  - Leukemia.
  - Pernicious anemia.
  - Scurvy.
  - Septicemia.
  - Pyemia.
- **Toxic agents**
  - Inorganic poisons
    - Mercury.
    - Arsenic.
    - Phosphorus.
    - Lead.
    - Corrosive and escharotic.
    - Acids and alkalies.
  - Organic poisons
    - Vegetable poisons in the form of drugs may lead to necrosis by their direct destructive action upon tissue, or secondarily by causing depleted conditions to the general system, or inducing diseases of special organs which may predispose to bone diseases, as may also animal poisons, such as bites of venomous reptiles, stings of insects, etc.

Case III.—Sam. F. K., aged twelve years. Necrosis. Extreme pain in lower jaw for about ten days. November, 1905, temperature, 102°, followed by swelling in right side. Was opened through skin surface below bicuspid region. Later an opening for pus was made under chin on left side. Some sequestra of necrosed bone were removed from time to time. Present time (March 6, 1906) opening from socket of the L. I. C. I. and along jaw from lateral to molar on left side, one erupting bicuspid on left side. Fistula under chin on left side. Thickened and swollen tissue from right inferior to left inferior second molar region.

There was necrosis of the inferior maxilla from the angle to the symphysis. Several previous operations had given no result beyond temporarily checking the progress of the disease. The fact that several teeth had become devitalized before their pulps were gangrenous and were constant sources of reinfection had been overlooked. These were removed with the dead bone, but at several points in the jaw the enamel caps of developing but still deeply embedded permanent teeth were noted, and these with much care were preserved. The result in both these cases made possible continued development and growth in the affected region. This could never have taken place if all of the teeth had been destroyed, and in natural course of development one side of the face would have been left deeply indented and much deformed.

The great prevalence of these extensive necroses in growing children is undoubtedly because the jaws are so filled with the crowns of developing teeth that circulation and bone nourishment is much impaired. Therefore bone infections from any cause easily result in extensive destruction.

Fig. 164 represents a women who gives a striking example of an acute, diffuse, suppurative periostitis and the involvement of adjacent tissue from an original infection by putrescent roots in the lower jaw. Extensive abscess followed, and on account of illness during pregnancy the patient was confined to her bed for several months. The prone position favored the spreading out of pus under the periosteum. Large numbers of scars from fistulæ may be noted as low down as the clavicle. The whole submaxillary area and the neck from jaws to clavicle at times were filled with pus so that the skin hung down like a pouch. This large abscess was continuous with one discharging through the center of the cheek and again at the outer angle of the eye. Irrigation through any one of the openings forced fluid through all the others. Prompt recovery followed removal of dead bone and thorough drainage.

Fig. 165 illustrates a type of necrosis quite frequently met with when caries of bone extends from the maxillary region until it includes either the maxillary sinus or the nose, or both, and the hard palate. In syphilitic cases this is quite a common form of necrosis, and in those cases the disease usually extends from the nose down through the hard palate. One young man, Mr. Harry D., aged twenty-five years, had

FIG. 164.—Woman with pus discharging from fistulæ in neck, cheek, and at the outer portion of lower eyelid from an original abscess of a lower molar tooth.

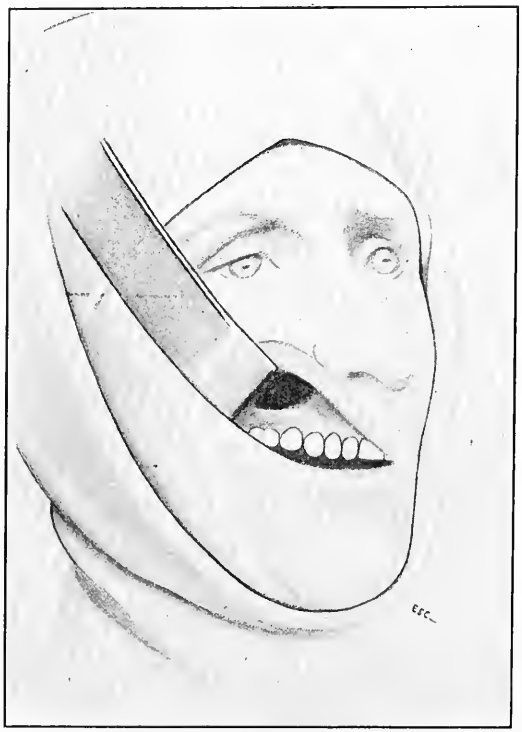


FIG. 165.—A typical case of necrosis, affecting bony walls of the maxillary sinus, the nose and the mouth after removal of necrosed bone.

had an accidental blow at the age of twelve. Discharge from region of incisors had been present ever since. Necrosis had gradually destroyed and included the anterior portion of the superior maxillary bones including the palatal processes, so that there was a large opening into the hard palate. He had suffered from the toxic effect of continuous suppuration in this region until the condition of his palate was very much disordered. He had been affected with what he believed to be rheumatism. Opening through the hard palate necrosis in the region of the lateral incisor was found. On account of the color, it was determined that this tooth had become devitalized years before as a result of traumatism. Upon opening it was found filled with pus. A history of trouble with the upper jaw following traumatic injury fifteen years before was given. He was sent to the author to have an opening in his hard palate closed. Examination disclosed the fact that bone destruction was yet in progress. Repeated operations had failed to do any good. His disorder had been diagnosticated as long-continued chronic rheumatism, but later it proved to be the result of long-continued septic intoxication. The opening had extended through the hard palate into the nose, as described by the patient through caving in of the bone. It was plain at a glance that an upper tooth upon the affected side was discolored, and it should have been understood by those who saw the case long years before that as a result of the traumatism at the time of injury the pulp in that tooth became devitalized and subsequently infected.

Over and over again in the author's practice such teeth have been found to be the cause of much long-continued necrosis; because of the fact that the crowns of the teeth were not noticeably decayed and there was no outward evidence of the tooth being affected except slight discoloration, this cause had been overlooked. It should be a matter of routine procedure to examine every tooth upon the affected side in every such case, not only by throwing reflected light from an electric mouth lamp through the teeth, but by tests of heat and cold. Whenever there is the slightest doubt of the vitality of the pulp of any tooth it should be opened and its exact status definitely determined. The loss of an occasional tooth pulp which it might become necessary to remove in the course of such treatment should not be considered for a moment in comparison with the serious results that follow the overlooking of such a tooth or teeth where extensive necrosis is already in progress or when operation of any kind is contemplated in that region of the jaws.

Tuberculosis of Bone.—Tuberculosis of bone is manifested in the form of an *acute tuberculous osteomyelitis* with miliary tubercles disseminated through the bone marrow or by *chronic tuberculosis of the bone*, which may begin in the periosteum, bone marrow, synarthrosis, epiphyseal disk, or epiphysis.

Etiology.—The bacilli most frequently reach the bone through the circulation, although infection may occur from contiguous structures or through the lymphatics.

Pathology.—Proliferation of fixed connective-tissue cells and leukocytic infection leads to the formation of granulation tissue. Absorption of the adjacent bone progresses in advance of the tuberculous formation. As a result of the specific poison of the tubercle bacillus, changes occur in the newly formed vessels which are followed by caseation at or near the center of the diseased area. By extension this may lead to perforation of the periosteum and cause *periosteal tuberculosis,* and lead to formation of what is known as *cold abscess.* When the hip is affected, the disease is known as *coxalgia;* when the knee, as *white swelling;* and when the vertebra, as *Pott's disease.* Large masses of necrotic bone may form and by continued bone destruction may affect articular surfaces or quickly destroy the usefulness of joints.

Symptoms, Treatment, and Prognosis.—See Tuberculosis, pp. 94 to 107.

Syphilis of Bone.—Syphilis of bone is responsible for many widely different lesions. In *congenital syphilis* the bones at birth sometimes show characteristic alterations. Calcification is irregular.

Syphilitic osteochondritis due to proliferated changes in the perichondrium and similar abnormalities of the periosteum cause more or less marked thickening and irregularity of form. In acquired cases bone lesions occur during the tertiary stage. During the secondary stage gummata in the periosteum or disturbance in the bone marrow, with degenerative and necrotic processes, may involve the overlying tissues and induce pyogenic infection. Bone destruction may continue until large areas have become necrotic, or through chronic diseases of the periosteum there may be osseous overgrowth resulting in osteophytic enlargement, irregularities of the surface, osteosclerosis, and similar structural alterations. The mouth and jaws, which offer unusual opportunities for infection through nasal, dental, pharyngeal, aural, and oral diseases, are frequently affected by manifestations of this disease in the form of necrosis. A very common symptom is an opening through the hard palate, which usually occurs from the extension of disease from the nose with destruction of the nasal cartilage vomer and the bony palate. (See Syphilis, p. 120.)

Actinomycosis of Bone.—This disease most commonly affects the jaws, but the vertebræ, ribs, and sternum may also be attacked.

Etiology.—It is due to infection by the ray fungus and favored by abrasions in the surface of the mucous membrane of the mouth, tooth sockets after the extraction of teeth, and by the fact that many persons have the habit of carrying a straw in the mouth or of using one as a substitute for a toothpick.

Pathology.—Proliferative and necrotic osseous changes resulting from this form of infection progress within the central portion of the bone and cause resorption of surrounding osseous structures. Subperiosteal involvement frequently causes marked increase in the size of the bones. (See Actinomycosis, p. 129.)

Leprosy of Bone.—Leprosy is sometimes marked by bone inflammation and necrosis. (See Leprosy, p. 139.)

Glanders.—Glanders usually attacks the periosteum, but may involve the bone also. (See Glanders, p. 134.)

Mercurial Necrosis.—Etiology.—Ptyalism, interstitial gingivitis, periostitis, and necrosis were frequent results in the days when calomel was extensively used by the laity without proper prescription, especially in malarial districts. The same results are not infrequently noted at the present time when mercury has been prescribed for syphilis and when by continued repetition of the prescription without medical advice excessive doses have been too long continued. The inhalation of fumes or dust containing mercury by workmen in mirror factories is also said to be a cause of chronic poisoning. Miners working in mercury mines according to Talbot are usually toothless at the age of thirty-five years.

Pathology.—In acute mercurial poisoning there are violent inflammatory and necrotic lesions of the gastro-intestinal tract. Degenerations of the renal epithelium and other organs sometimes occur. In subacute cases, ptyalism is believed to be due to pathological change in the salivary glands, but this is not definitely understood. In chronic cases the pericemental tissues in common with overlying and surrounding structures undergo degenerative changes which render them particularly susceptible to inflammation.

Mercury is eliminated by active stimulation of all excretory organs. When elimination is insufficient both lead and mercury accumulate in the system. It is believed that they form albuminized combinations in the tissues with resultant affection of both the central and peripheral nervous systems. Trophic changes occur which, assisted by accumulation in the vessels, cause thickening of the intima-tunica and result in endarteritis obliterans. When the circulation is thus impeded and there is local irritation by accumulation in the vessels with weakened general resistance, owing to disturbance of the eliminative organs, degenerative changes result.

Symptoms.—In the subacute stage there is an excessive flow of saliva, a dark bluish line forms at the borders of the gingivæ, the gums become swollen and everted, the teeth loosened and elongated, and these symptoms are followed by the discharge of pus from the alveoli and the formation of pus pockets around the teeth. Acute, diffuse, suppurative periostitis with symptoms of acute inflammation of overlying tissue is followed by the formation of sequestra of bone and complete or partial necrosis. Accompanying the bone destruction there is usually extensive ulceration and loss of the soft tissues of the mouth which may involve the cheek, muscles of the soft palate, or the oral mucous membrane. Marked contraction and scar formation is a notable feature in chronic ulceration of this character, and closely resembles syphilitic ulceration in this respect.

Diagnosis.—In the early stages differentiation must be made from interstitial gingivitis from other causes, gangrenous stomatitis, acute leukemia, pernicious anemia, and syphilis. The history of the case, blood counts, and general physical examination, or the Wassermann test, where no clear history may be obtained, usually supply the distinctive diagnostic indications.

Treatment.—Discontinue the administration of mercury and avoid exposure to mercury in any form, and treat the same as any other form of necrosis.

Phosphorus Necrosis.—Phosphorus necrosis was a common type before employees in large factories were protected from the fumes of phosphorus.

Etiology.—This form of necrosis is due to the contact of phosphorus or its fumes with the periosteum or pericementum of the roots of teeth, or infection by microörganisms in a state of weakened bodily resistance induced by the poisonous effect of the phosphorus. The chewing of matches has sometimes been recognized as a cause. It has seldom been known to affect the mouths of persons with sound teeth. Carious teeth and those otherwise diseased have most frequently been held responsible for its occurrence.

Pathology.—In phosphorous poisoning there is catarrhal inflammation of the gastro-intestinal mucous membrane and fatty degeneration which affects the liver, other internal organs, the heart muscle, and intima of the bloodvessels. In the chronic forms catarrhal inflammation of the respiratory tract paves the way for bone infection, and the results are quite similar to bone necrosis under other conditions.

Symptoms.—The only symptoms of phosphorus necrosis which might be considered as pathognomonic of this form of necrosis have been claimed to be the peculiar pumice-like appearance of the dead bone and the fact that the periosteum becomes unusually resistant and retains its vitality even though the bone undergoes extensive osteoporous necrosis. The author, however, has noted the same characteristic quite frequently in necrosis of the jaws, where there was no possibility of phosphorus having been an etiological factor.

Treatment.—Treatment consists of prevention of exposure to phosphorus, assisting the process of its elimination from the system, and upbuilding the general health of the individual to increase resistance and aid in overcoming the effect of the poison. In other respects the treatment of diseased bone is the same as for other forms of necrosis.

Arsenical Necrosis.—Etiology.—This form of necrosis has usually been caused by careless application of arsenical paste for the devitalization of tooth pulps. Fortunately cocain pressure anesthesia for the removal of pulps has largely done away with danger in this respect.

Pathology.—The powerful escharotic action of the drug in contact with the pericementum or periosteum of the alveolar structures surrounding the teeth, and particularly the bony septum between the

roots of teeth, excites an acute inflammation which destroys the affected bony area.

Symptoms.—The symptoms include discharge of pus, exfoliation of small portions of bone, and occasionally the loss of one or more teeth that have become devitalized and loosened. The extensive necrotic areas, involving the soft tissues of the mouth as well as the alveolar process, which have been reported, were probably due to infection, since the action of arsenic is more or less self-limiting.

Treatment.—The treatment consists in complete extirpation of diseased bone and soft tissue, and the local application of tincture of iodin or the hydrated oxide of iron, which it has been claimed will neutralize the effect of arsenic in the tissue.

In all other respects the treatment is the same as for other forms of necrosis.

Pathology.—When a mass of bone, whether large or small, has been destroyed through the processes described in connection with osteomyelitis and infection from periostitis a line of demarcation is formed between the living and dead bone which is quite similar to that of gangrene. Where the dead tissue joins the living, phagocytic cells attack the osseous matrix forming the line between the dead and living structures, the result of secretory and phagocytic action of the leukocytes and osteoclasts is that a portion of dead bone becomes separated from the living bone and becomes what is known as a *sequestrum*. The process by which this is accomplished is called *exfoliation*. The newly formed bone surrounding the sequestrum is called the *involucrum*, through which there may be little openings called *cloacæ*. Suppurative processes extending to and through the overlying tissues may form a sinus or sinuses for the escape of pus, or the sequestrum may become enclosed in masses of fibrous or osseous tissue, which sometimes hold and prevent its exfoliation and in this way give rise to chronic conditions that sometimes persist for many years. Sometimes liquefaction of tissue takes place without the formation of a sequestrum, there being a continued softening and crumbling of the bone which either becomes roughened with more or less excavated areas upon the surface or a softened mass within the bone. This we recognize as caries.

Symptoms.—The symptoms of necrosis of the jaws are necessarily modified by the character of the cause. Traumatic injury would be evidenced by inflammation of the periosteum in common with overlying injured parts. Infection from an acute dento-alveolar abscess would present the predominant symptoms of this affection during the early stages. In all the *non-traumatic* or so-called *idiopathic* cases there are present the symptoms of acute infectious diseases. These vary greatly, according to the severity of the infection, resistance of the individual, and conditions governing the actual cause. There may be chills, fever, prostration, temperature ranging from 101° to 105° F., or even higher, with severe local pain and great prostration.

The toxemia may be so rapid as to cause delirium, stupor, endocarditis and death, or there may be acute local pain with but slight evidence of general symptoms and infection, or subacute and chronic periostitis, osteomyelitis, or ostitis may lead to the destruction of large areas of bone with almost no serious objective symptoms and complete absence of pain, until in due course there is formation of pus and the final exfoliation of the bone. Tenderness to touch over a more or less considerable area which is marked by redness is usually an early symptom.

Caries of bone, being a slower process, is usually unattended by painful symptoms other than those incident to acute infections, which may be the first cause of the formation of the bone abscess. The most common cause of caries in the maxillary bones is dento-alveolar abscess, which, having become chronic, proceeds slowly with bone disintegration until considerable excavations in the bone have been accomplished.

Diagnosis.—When sequestra of bone have been formed there is usually discharge of pus, which by making pressure upon the overlying surface may be seen to exude through several fistulæ. Touched with a probe or suitable instrument, such bone will be found to have lost its velvety feeling and is rough. Usually slight motion of the sequestrum can be detected. In carious conditions due to extensive and long-continued chronic abscesses the external bony wall will usually be found to be extremely thin and yielding to pressure. It is this characteristic which often serves to indicate the existence of a carious area that would not otherwise be suspected. Surrounding bone, not yet fully disentegrated but without normal vitality, is also recognized by its rough dead feeling. Perhaps in no other part of the body is recognition of the exact cause of necrosis so necessary or difficult. The differentiation of different diseases and forms of infection through which the local disease might have been caused is equally important in all fields of practice, but on account of the multiplicity of causes of diseases of the teeth, and the great variety through which infection might occur, careful distinction is exceedingly necessary.

Treatment of Necrosis and Caries.—In the acute stages, when pain and other symptoms of acute inflammation are present and before Nature has had an opportunity to complete the process of separation between dead and living bone, treatment is limited to measures which relieve the pain, check the progress of the inflammation, and if possible abort the formation of complete necrosis. Sources of infection or irritation must be brought within control or at least receive appropriate attention. Incision through the overlying tissues and periosteum down to the bone may be necessary to check the progress of an acute diffuse suppurative periostitis. Painting the surface with tincture of iodin serves the double purpose of antisepsis and local absorption. Hot applications in the form of capsicum plasters, or similar agents applied to the mucous membrane surface immediately

over the point of greatest tenderness sometimes give relief and facilitate the progress of pus toward the surface, and this aids more complete relief. Hot-water bags or hot fomentations applied to the face are always gratifying and sometimes quite beneficial. Relief of pain by the use of hypodermic injections of codeine or morphin or the internal administration of suitable remedies is occasionally necessary to tide over the period until surgical relief may be given. All the bodily eliminative processes should be called into action. Cathartics, diuretics, and sudorifics should be administered if required; usually, however, the increased activity of the kidneys and sweat glands may be more naturally stimulated by free administration of warm drinks, hot foot baths, warmth to the surface of the body, etc. The bodily temperature should be carefully noted, and the degree of fever, which in the acute fulminating cases is sometimes high, may be taken as an index of the relative virulence of the infection and bodily resistance of the individual. Cold sponge baths, sponging with tepid water followed with alcohol, and high bowel flushing offer the most satisfactory means of controlling the fever, which after all is only one of nature's means of fighting the infection and should not be masked by the use of antipyretics or other drugs, the ultimate effect of which is almost invariably bad.

Nourishment should be in concentrated, highly nourishing, easily digested form. When, as sometimes happens, the entire digestive tract becomes so disturbed, as to make the administration of food by stomach inadvisable, then rectal nourishment should be given and supplemented by frequent administrations of normal salt by rectum slowly, according to the drop method.

Virulent infection with weakened bodily resistance frequently leads to toxemia of serious nature, and ill-advised attempts to give surgical relief through opening the vessels to direct entrance of infection has been known to result in true septicemia and pyemia. In all such cases the effect of general septic infection must be combated in addition to local treatment. Hypodermoclysis (the administration of the normal salt subcutaneously into the tissues) is required in the graver cases of this affection to stimulate depleted vital forces. Intravenous administration of normal salt is also recommended as giving a more direct and therefore more prompt and efficient effect. Transfusion of blood when performed by a proper technic and sufficiently safeguarded is undoubtedly the most effective means of combating every form of septicemic or pyemic condition.

When actual disintegration of bone has been accomplished the treatment briefly outlined is as follows:

1. *Correction of the cause.*
2. *Relief of pus.*
3. *Sterilization,* local antiseptic treatment to prevent extension.
4. *Removal of Dead Bone.*—Distinction must be made between necrosis and caries in treatment. A sequestrum or sequestra should

be taken out intact if possible. Carious bone must be removed with a surgical or dental engine bur, a chisel, or curette, and all roughened bone borders made smooth. This distinction is very necessary because an attempt to get out a sequestrum of bone with a dental bur would only result in breaking up little particles of bone and forcing them into the tissues, thus leading to continuation instead of relief of the disease. After the sequestrum has been removed the bone borders may be smoothed by the use of a 10 to 25 per cent. solution of sulphuric acid or better still with a curette, and all carious bone removed until the smooth velvety surface of healthful bone can be recognized.

5. *Packing.*—If the cavity in the tissuse remaining after the dead bone has been dislodged or cut away is of such form or situation as to be unfavorable to drainage, then it may be necessary to insert a packing. This is best done with gauze, because cotton is likely to leave threads behind to continue irritation and infection afterward. The gauze should be wrung out in a 2.5 per cent. carbolic acid solution, 1 to 10,000 mercuric bichloride, 10 per cent. tincture of iodin, or some similar antiseptic, and sealed in with collodion or gutta-percha dissolved in chloroform. Once each day this should be changed to avoid infection.

When the wound cavity can be made sufficiently open and saucer-shaped to facilitate natural drainage and prevent lodgment of disadvantageous agents this should be done, and then no packing ought to be used; but the frequent holding in the mouth of dioxogen, or any of the well-known suitable germicidal agents, must be depended upon to prevent infection.

General treatment is often required to overcome the toxic effect of the disease. Ovoferrin, other forms of iron, quinine, cod-liver oil, and tonics are often valuable.

Diseases such as syphilis, tuberculosis, actinomycosis, leprosy, and glanders must each receive its own special treatment as indicated in addition to the local treatment.

FRACTURES OF THE JAWS.

A fracture may be defined as a break in the continuity of bone or cartilage caused by direct force or muscular contraction.

Varieties of Fractures.—Complete.—1. *Simple.*—A single fracture without division of the overlying soft tissues.

2. *Compound.*—Fracture with broken bone surfaces exposed to the external air by division of the overlying parts.

3. *Multiple.*—Two or more distinct fractures of the same bone.

4. *Comminuted.*—A fracture in which the bone is crushed or broken into small communicating fragments.

5. *Complicated.*—A term usually applied to fracture accompanied by some serious injury of the parts in the region of the fracture, as important nerves, bloodvessels, joints, etc.

6. *Impacted.*—When the fractured fragments of bone are driven into each other and more or less embedded.

Fractures are further described by the following self-explanatory terms: Tranverse, oblique, longitudinal, dentated, spiral.

Incomplete Fractures.—Green-stick fracture or partial separation of the bone fibers allows the bone to bend, but it is not completely broken off.

Other forms of incomplete fracture are described as:

Fissured.	Punctured.
Indented or depressed.	Perforating.

Special Forms of Fracture.—Fractures not invariably or distinctly within either of the foregoing classes are:

Pathological Fractures.—This is due to preëxisting disease, as from some constitutional condition affecting the bone structure, fragilitas ossium, sarcoma, cancer, senile atrophy, etc.

Subperiosteal Fracture.—Fracture of the bone sometimes occurs without separation of the periosteum in cases of infants and very young children.

Gunshot Fracture.—Gunshot fractures necessarily depend upon velocity, character of the missile, and the kind of bone at the seat of injury. Cancellated structures yield to pressure without extensive lateral injury. Compact bone structures such as in the lower jaw are likely to suffer extensive comminution with fissured fractures. Splinters of bone may also be forced in different directions and the size of the wound materially increased.

Alveolar Fractures.—This form consists in splitting or fracture of the alveolar process not involving other portions of the maxillary bones.

Intra-uterine Fractures.—The weakened osseous system of the offspring of mothers affected by scurvy, syphilis, and struma may sometimes suffer fracture before birth. This does not include injury by instruments in delivery.

All fractures are also described as:

Recent.	Old.
United.	Ununited.

Etiology.—Superior Maxilla.—The superior maxillæ with the malar, nasal, palate, lacrimal, ethmoid, and sphenoid bones form an almost indivisible complement in the bony structure of the upper part of the face, which is greatly exposed to traumatic injury. It is, nevertheless, true that these other bones serve to protect the maxillæ, so that fractures of the upper jaw are comparatively rare. They usually result from more or less unusual force directly applied, such as the kick of a horse, falling upon the face or from some height, runaway, automobile, motor cycle, and similar accidents, gunshot injuries of the mouth, and not infrequently when the lower jaw is forcibly driven against the upper.

Inferior Maxilla.—The inferior maxilla, because of its exposed situation, its size, and shape, is much more subject to fracture than the

superior maxilla, or, in fact, any other bone of the face. The weakest point in a normal lower jaw is generally recognized as being slightly anterior to the mental foramen and in an edentulous jaw at or in line with the mental foramen. Naturally these are the points at which fracture most frequently occurs. Fractures in this region are quite common because of exposure of the likelihood of blows upon the face or neck affecting the side of the jaw, and also because in such large numbers of people the first molars or bicuspids have been lost with corresponding absorption of the alveolar structures to weaken the jaw. At the angle of the jaw fracture is also quite frequent. Many cases of fracture in this region have been reported from extraction of third molar teeth, especially when impacted. Beyond this general characterization the exact order of frequency in the occurrence of fractures through the symphysis, the ramus, the neck of the condyle, and the coronoid processes, situations in which fractures of the mandible may occur, is according to the author's experience too uncertain to warrant definite statements.

Symptoms.—Symptoms of fracture of the jaws are: (1) Deformity, (2) unnatural mobility, (3) crepitus, (4) loss of function; (5) pain, which may be constant or only on movement of the jaws, or the fractured ends of the bone; and (6) in compound cases the fractured ends of the bone may project into the mouth through the wound in the soft tissues.

Swelling and other symptoms are dependent upon the extent of traumatic injury and infection.

Diagnosis.—The distortion of facial features may be sufficiently indicative without other symptoms. Quite often this is disguised by swelling of the overlying soft tissues. When there are teeth in the jaws disarrangement of occlusion is usually a marked and important symptom. The teeth upon one side of the line of fracture may be higher or lower than those upon the other, or they may be out of alignment in a lingual or buccal direction with deformity still more evident. By firmly grasping the bone upon each side of the seat of injury unusual motion is usually detected, and the crackling, scraping sound (crepitus), as the ends of the bone are rubbed against each other, completes the diagnosis.

Fractures of the Superior Maxillæ.—Injury sufficient to cause fracture in the upper jaw is usually so severe and the bone so broken into different portions that diagnosis is quite simple. Nevertheless, upper jaws have frequently been broken and the fact was not discovered until long after union had taken place with marked deformity of the dental arches. This has occurred in many instances because fracture of the superior maxilla occurred simultaneously with that of other bones of the face, the latter masking the maxillary fracture and causing it to be overlooked.

Notwithstanding the frequency of comminuted fractures of the upper jaw, an attempt has been made to recognize certain definite

fracture lines. Thus a *transverse fracture* has been described by Guerin which extends backward along both sides of the upper jaw below the malar bones until it includes the pterygoid processes. The roof of the mouth, including the teeth, drops down until it rests upon the floor of the mouth and is to some extent displaced in a backward direction. This form of fracture quite frequently occurs from blows upon the face just below the nose. In one of the author's cases it was caused by the kick of a mule. Fracture closely associated with diastasis of other bones of the face is usually evidenced by division through the median palatal suture, and is caused by accidents which jar or drive the lower jaw forcibly into the upper in such manner as to force the maxillæ apart. In one of the author's cases there was an opening through the hard palate with division of the soft tissues when the bones were forced apart and disarticulation of the zygomatical maxillary suture was revealed when the infra-orbital outline was followed with the finger. The separation between the maxillary bones was also evident at the intermaxillary suture and by space between the central incisor teeth. In another case, a patient of Dr. G. W. Fox, of Milwaukee, an automobile accident had caused similar fracture with diastasis of nearly all the facial bones, accompanied also by fracture of the malar bones. Force applied against the upper jaw obliquely outward or upward upon the side causes splitting of the alveolar process and occasionally oblique fractures extending deep into the body of the bone. Alveolar fractures are quite commonly incidental to extraction of teeth.

Fractures of the Inferior Maxilla.—Ordinarily fractures of the lower jaw present typical and therefore easily recognized symptoms. When caused by falling and striking upon or blows at the point of the chin, which tend to drive the jaw backward and upward, there is displacement of the mandible in a backward direction. This may be caused by fracture of one or both condyles or fracture of the anterior wall of the external auditory meatus, and in these cases occasionally the differentiation is somewhat difficult. Fractures of the condyloid processes usually occur at the neck. If upon one side only, there is dislocation of the chin and jaw, which are pulled toward the injured side, chiefly because of the action of the internal pterygoid muscle of the opposite side. Unilateral fracture of the neck of the condyloid process is distinguished from dislocation of the jaw, because in these cases the jaw is drawn toward the normal side. When both condyloid processes are broken the lower jaw is drawn upward and backward and there is more or less loss of movement with tendency to necrosis. When the condyles are intact, but in being driven backward have caused fracture of the anterior wall of the external auditory meatus, the most marked symptom is occlusion of the external auditory canal when the jaws are closed or the mandible forced backward.

Fracture of the glenoid cavity, which is necessarily associated with this condition, may become serious if inflammatory processes are excited by infection and lead to permanent ankylosis. There is slight

depression in front of the external auditory meatus; the broken articular surface of the condyle may be pulled forward and inward by the external pterygoid muscle, and can be felt by drawing the jaw forward

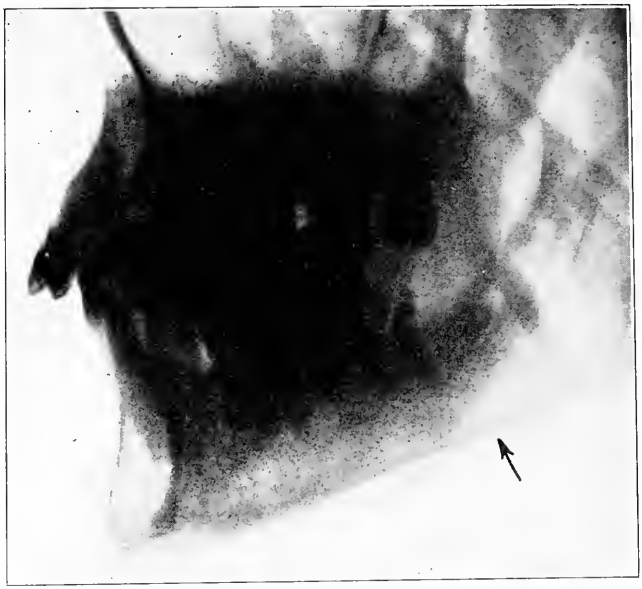


FIG. 166.—Radiogram of the jaw of a young woman, one of the author's cases. This fracture through the lower jaw resulted from an ill-advised attempt to extract an impacted third molar in a dental office.

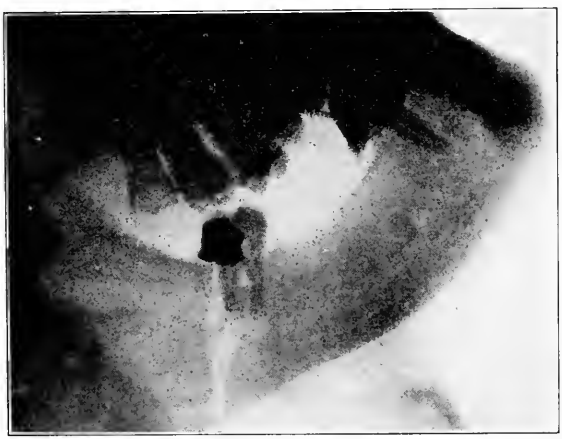


FIG. 167.—Fracture of tooth and jaw. The tooth becomes infected in such cases and must be removed. (Dunning.)

and pressing the condyle from within outward with a finger placed upon the upper lateral wall of the pharynx. Such fractures may sometimes be reduced in this way.

FIG. 168.—Impacted cuspid in line of fracture; a predisposing cause and an obstacle to healthy repair of bone. (Dunning.)

FIG. 169.—Pathological fracture; no history of any trauma, but long history of chronic abscesses of jaw. Fracture occurred while patient was eating crust of bread. (Dunning.)

Fractures at the Symphysis.—Fractures through the symphysis are usually vertical and cause comparatively little dislocation. With fractures of the coronoid processes the symptoms are usually slight except when the jaw is moved extensively. This form of fracture is exceedingly rare, and is always accompanied by fracture of other bones. Its existence would therefore only be suspected under such conditions and when the injury was of such direct character as to make such injury possible. Palpation by the fingers within the mouth usually leads to discovery.

Fractures of the ascending ramus are rare because it is well covered with muscles. They can best be felt from within the mouth and by passing the finger along the posterior border of the ramus externally.

In most cases fracture of the lower jaw, can be distinguished by the break in the natural outline, which is felt by passing a finger along the lower and posterior border. By all means the most perfect diagnostic aid in doubtful conditions are the *x*-rays, by which not only the existence of fracture may be established but its exact character as well.

Treatment of Fracture of the Maxillæ.—The methods of retaining fractured lower jaws are as follows: (1) By bandaging alone; (2) by ligating teeth upon each side of the fracture as first done by Hippocrates and used in one form or another ever since; (3) by *splints* constructed of metal, plaster of Paris, or other suitable material laid upon the external surface of the chin, the side of the jaw or behind the angle with a few layers of cotton pad to prevent irritation and firmly bandaged; (4) by *interdental splints, i. e.*, supports placed between the jaws, a method first used by Hayward in 1858 and modified and improved by Gunning in 1861; (5) by *attachments to or upon the teeth of the affected jaw only;* (6) by *wiring the teeth of both jaws together;* and (7) by *wiring the bones,* of which a successful case was reported by Buck, 1847.

In deciding upon the splint or appliance that may be used to hold the fractured bony parts in position there are certain important principles which must be kept in view to govern selection. These in the order of their relative importance are as follows: (1) *Perfect approximation* of the parts; (2) *immobility;* (3) *freedom in taking nourishment;* (4) *facility in keeping the mouth surfaces clean;* (5) the possibility of *frequent observation of the parts;* and (6) *freedom in the use of the jaws,* which necessarily implies their not being bandaged or bound together by wires.

In some forms of fractures all of these desirable conditions can be secured, and in others this is impossible. It therefore becomes necessary to select the kind of splint that will give the greatest possible comfort to the patient with the best promise of a good result by securing as many of these advantages as may be practicable. A vast amount of ingenuity has been expended upon different forms of appliances for retaining fractured jaws. An attempt at enumerating and describing them would be both impractical and unnecessary if the foregoing principles are kept in mind. Selection may be made from a few

simple, thoroughly practical forms, which can be modified so as to be adapted to almost any variety that may occur. The illustrations and descriptions are therefore confined to these examples.

First aid in these cases depends largely upon the character of the injury and the condition of the patient at the time treatment is begun. Many times the shock attendant upon the accident, concussion by injury to the head, or complications make it necessary to be content with such temporary measures as may give the best possible immediate relief with a view to more accurate and effective treatment when other conditions are more favorable. In one of the author's cases, for example, a man was butted through a fence by a bull, and in addition to the fracture of the jaw, suffered fractured ribs, also with traumatic injury to the lungs, which brought about a pneumonia and temporarily endangered his life. In the absence of grave general obstacles, the swelling of the parts, with attendant pain and soreness in manipulation and difficulty in opening the mouth, sometimes renders perfect adjustment at the time impossible. In these cases for temporary purposes and to hold the parts during the period necessary for the preparation of a proper permanent support, an interdental splint is valuable. It is made of modelling compound, softened in warm water, molded into proper form, placed between the jaws and held there a few minutes until it hardens, then removed and trimmed into suitable form with an opening in the anterior part, as shown in Fig. 172. It serves an excellent purpose by retaining the fractured bone in comfortable position when it is properly placed and the jaws are securely bandaged, until such time as a permanent substitute may be inserted. A few cakes of dentist's modelling compound should be part of the equipment of every surgeon's case.

The author's experience in one instance, however, may serve to impress the need of caution in one respect. In this case the modelling compound splint was left in place longer than usual on account of the precarious general condition of the patient due to the accidental injury. Directions were given at the hospital to have the mouth freely irrigated through the opening in the anterior part of the splint. Upon returning several days later, it was found that warm water had been used and the compound softened until both shape and usefulness were lost. Irrigation with antiseptic solutions may be freely given without disturbing the splint, but such solutions should always be cold whenever modelling compound is the material from which the splint is made.

Reduction of the Fracture.—Antagonism chiefly due to the digastric, geniohyoglossus and mylohyoid muscles upon the one hand, and the masseter, temporal, and the pterygoid muscles upon the other, when lost by a fracture of the jaw, if the parts are sufficiently separated to lose resistance cause more or less marked disarrangement. Naturally this is greater when the fracture is double or comminuted, or when a segment of bone is actually lost. Under favorable conditions the manipulation necessary for production and proper alignment is accom-

plished with comparatively little pain and without much difficulty. Sometimes, however, the pain, tense contraction of the muscles due to irritation, extreme nervousness of the patient, and swelling or other

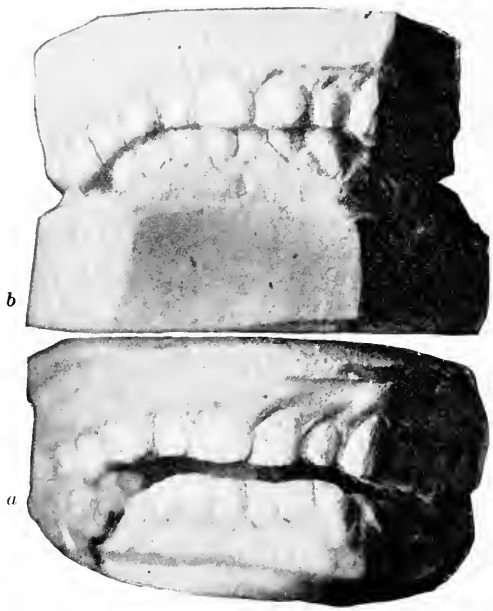


FIG. 170.—*a*, cast of the mouth of one of the author's patients, showing line of fracture through the lower jaw, with typical disarrangement of the occlusion of the teeth; *b*, the same case after treatment.

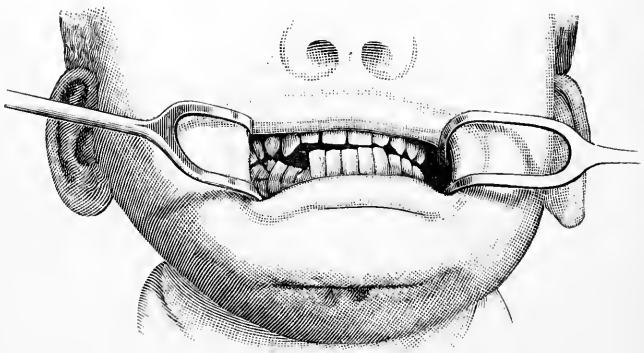


FIG. 171.—Fractured lower jaw, with characteristic deformity. (After von Bergmann.)

unfavorable symptoms resulting from injury, make satisfactory adjustment without general anesthesia practically impossible. In the absence of contra-indication, ether should be administered in order

that accurate satisfactory reduction of the fracture may be accomplished with complete muscular relaxation (Figs. 170 and 171).

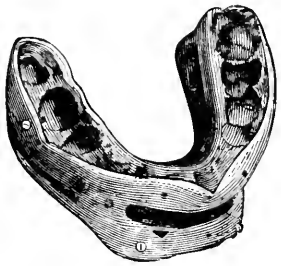


FIG. 172.—Gunning's interdental splint, with opening for introducing food.

Methods of Fixation.—Transverse, comminuted, or multiple fractures of the upper jaw require general support, which may be given by binding the lower jaw firmly against the upper if the occlusion of the teeth prior to the accident was sufficiently regular. The difficulty in administering nourishment, which must be given through a tube, passed along the buccal surfaces of and behind the molar teeth, through

FIG. 173.—Radiograph of one of the author's patients, a boy twelve years old, run over by an automobile. Fracture between the cuspid and lateral incisor teeth on the right side, and in the region of the first molar on the left side is shown held in fixation by a cast aluminum interdental splint.

the nose, or in a limited way per rectum, is an objection to this method. The old-fashioned *interdental splint* (Fig. 172) made of vulcanized rubber gives the necessary support, allows nourishment to be taken through the opening in the splint, and permits of fairly satisfactory cleansing by irrigation.

Kingsley's interdental splint (Figs. 175 and 176), as modified and described by Marshall, is made of rubber vulcanized upon an impression

of the upper teeth against which the lower jaw has been pressed sufficiently to mark the outline of the crowns of their occlusal surfaces. Wires have been imbedded into the sides and so bent as to pass out around the angles of the mouth and extend outside the cheek surfaces.

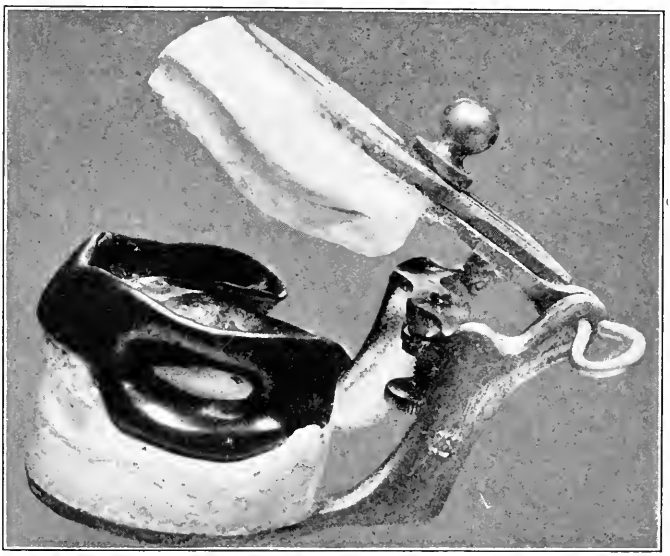


Fig. 174.—Modification of the Gunning interstitial splint as used by Dunning for edentulous upper jaw, when lower bicuspids and molars are also missing.

The wires make it possible to bind the appliance with elastic or other bands passed over the head in such manner as to support the fractured upper jaw without restricting movement of the lower jaw. It has the additional advantage of permitting constant observation, cleansing

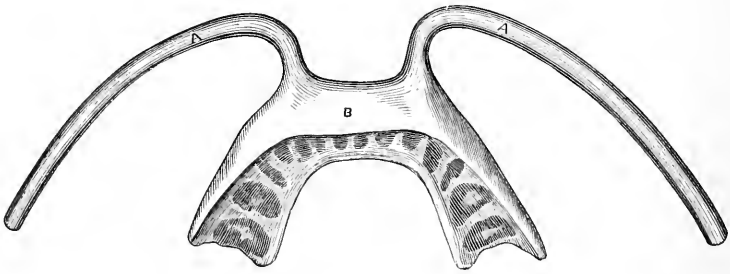


Fig. 175.—Kingsley's interdental splint.

and local treatment of the parts, as well as freedom in taking food. When a sufficient portion of the upper jaw is left firm and immovable, *a metal splint cemented to the teeth* (Fig. 177) may be employed as in the case of the lower jaw (except that it is in reverse position), with almost

entire absence of discomfort and full functional possibility. Even though there may be diastasis of facial bones with fracture of the malar, the condition is not necessarily a serious one from the standpoint of retention. In some of the author's cases the molding of the

FIG. 176.—Kingsley's splint applied.

parts and adjustment of the bones by pressure was sufficient, and only slight support secured by adhesive plaster laid upon the surface to make slight tension in the desired direction or properly adjusted bandages, and keeping the patient as nearly absolutely quiet as possible for a sufficient time, was required.

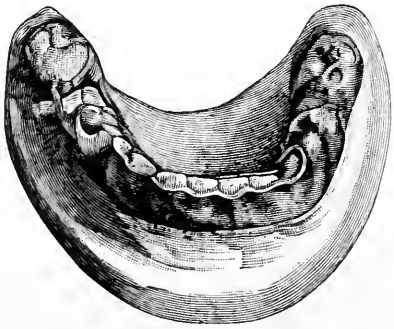


FIG. 177.—Dental splint applied to cast.

The method of *wiring the lower to the upper teeth* to secure fractured jaws was first advised by Dr. Thomas L. Gilmer.[1] Dr. Gilmer is a strong advocate of this method, and his good results in large numbers of difficult fractures seems to warrant his position. He says:[2]

[1] Arch. Dent., 1887, p. 388.

[2] International Congress, 1904, ii, 185.

"In cases of fracture of the ascending ramus, or at any point posterior to the third or second molar, if most of the teeth or a sufficient number are in the mandible, the best results are obtained by wiring the upper teeth to the lower. This may be done with Angle's bands, it is true, but it is not so conveniently done, I think, as by wiring the upper teeth to the lower teeth. I believe that this is a better method of treating fractures in the angles or ascending ramus than by drilling through the bone, unless there are complications.

"I discard the use of bandages because that may interfere with the circulation and retard recovery."

He uses a small, very soft annealed German silver wire.

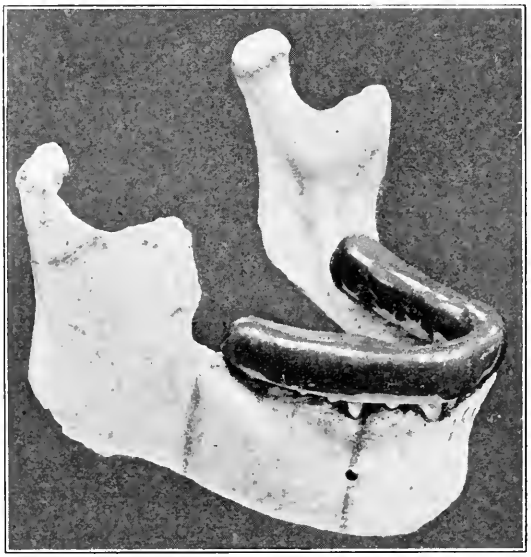


FIG. 178.—Cap splint or single arch splint used whenever there are one or more sound teeth on either side of the line of fracture. (Dunning.)

The objection to fixation of the parts in this way is, that unless carefully done there is tendency to loosen the teeth. This, however, need not necessarily occur, and is a question of technic rather than of method. Nourishment can be taken with the jaws together but not so comfortably or so satisfactorily as when the mouth can be opened. Moreover, the opportunity to view the inside of the mouth, which is prevented, is also important. It is therefore advisable to wire the teeth together only when more accurate results can thus be secured than by other forms of dental or interdental splint.

It is very natural that there should be some question as to priority of invention or application in the use of methods such as Angle's for fixation of fractured jaws. But there can be no doubt of the fact that Angle, with his well-known ability to bring to perfection any appliance

which he devises or employs, has done more than anyone else toward making treatment of fractured jaws simple and effective. The following illustrations of Angle's methods (Figs. 179, 180 and 181) are given

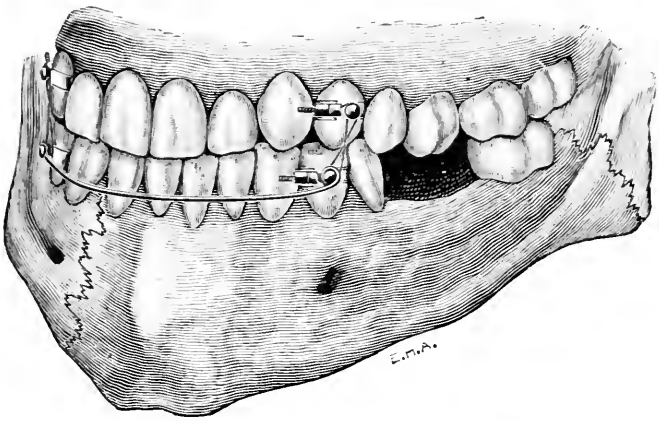


Fig. 179.—Splint for fractured lower jaw. (After Angle.)

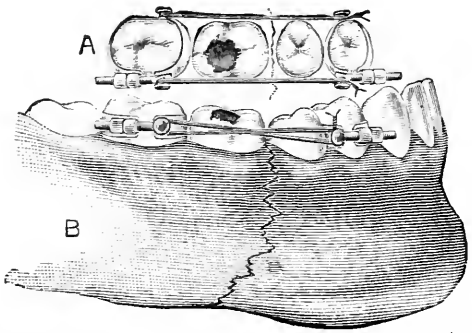


Fig. 180.—Splint for fractured lower jaw. (After Angle.)

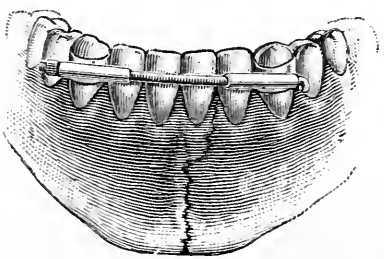


Fig. 181.—Splint for fractured lower jaw. (After Angle.)

with full credit to the author and without prejudice to any others who may have previously employed similar but almost certainly less perfect appliances. Naturally, in the course of extended practice,

whatever the original suggestions may have been, one finds one's self making certain modifications which appear to be improvements. In

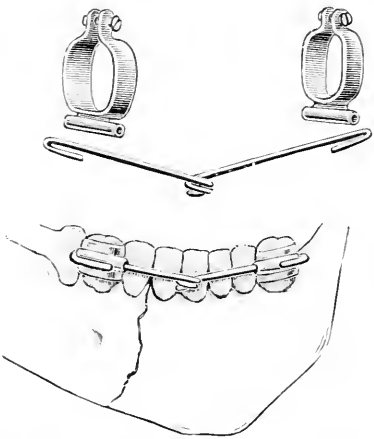


FIG. 182.—Löher's splint.

FIG. 183.—Illustrates one of the author's cases. The subject, a young man, suffered severe cranial injuries as well as a fractured upper jaw, from a fall from the roof of a shed. His cerebral condition necessarily claimed first attention. Later the splint was applied with nuts and screws so adjusted to metal bands cemented to his teeth that both fixation and correction could be applied simultaneously. He was able to eat comfortably immediately after the splint was applied.

this way the author has adopted certain modifications of Angle's appliance which have seemed in certain cases to be an improvement

(Figs. 179, 180 and 181). Fig. 182 shows Löher's; Fig. 184, Sauer's; Fig. 185, Martin's; and Fig. 186, Hammond's splints. These are self-explanatory.

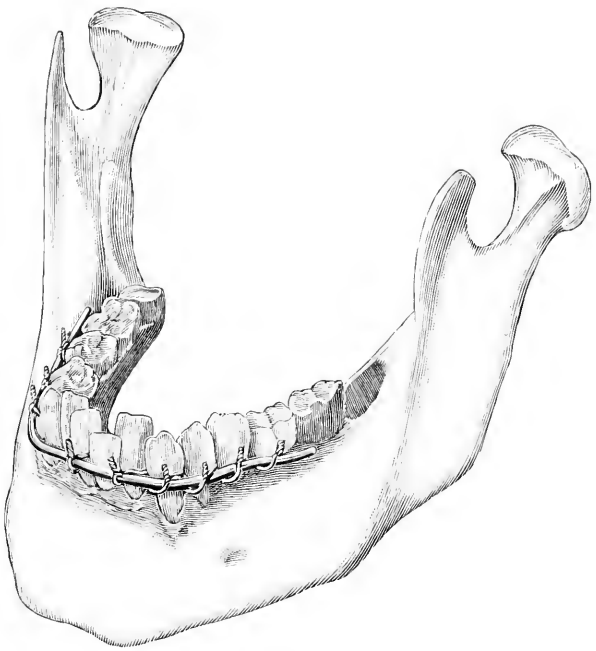


FIG. 184.—Sauer's splint.

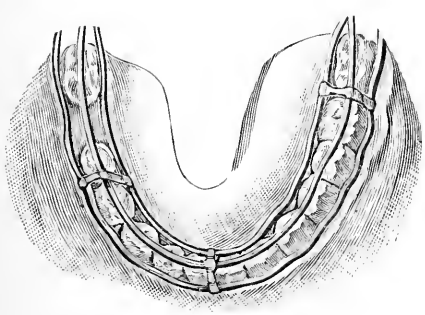


FIG. 185.—Martin's splint.

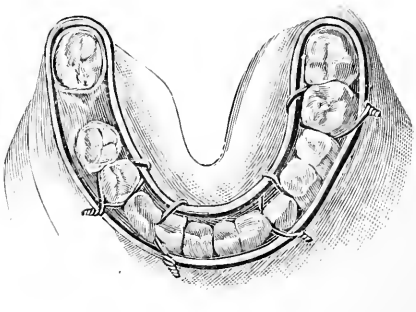


FIG. 186.—Hammond's splint.

Dr. J. D. Patterson, of Kansas City, makes a practical suggestion for the treatment of a fractured edentulous jaw by utilizing the plate that has been worn by the patient and adjusting the parts to fit the form of the plate.

Dr. Patterson is also entitled to credit for devising the bridge splint attached to teeth upon each side of the fracture, and used in the first instance to bridge across a space caused by the loss of a section of the lower jaw from gunshot fracture, but adaptable also for use in a similar manner for resection. By the use of this splint the parts are kept

FIG. 187.—Gunshot fracture; cap splint in position. (Dunning.)[1]

apart and securely in position until such time as intervening tissue may be formed and great deformity avoided. This method has been of great service in the present war.

He concludes his description of the first use of this splint on a patient, the anterior part of whose jaw had been destroyed by a shot from a Winchester rifle in 1891, with the following statement:

FIG. 188.—Shape of splint before being fitted to chin. (Roberts.)

FIG. 189.—Splint molded to fit chin. (Roberts.)

"Upon removal of the splint I was delighted to find that the bone had reformed where it had been entirely missing, and the sides were firmly held in their places without any change during the four days when I was remodelling the bridge."[2]

[1] Fractures of the Maxilla, Jour. Amer. Med. Assn., Jan. 9, 1915.
[2] Western Dent. Jour., 1891, p. 536.

External Dental Splint.—Many forms of splints to be applied upon the outside of the face and chin have been devised. These are equally unnecessary and are occasionally required. The splints illustrated in Figs. 188 and 189 are an example of splints of this character which are valuable because of their simple construction.

In fracture through the angle of an edentulous lower jaw it is sometimes necessary to hold the ramus forward against the body of the mandible, and wiring the bones may sometimes be avoided by molding modelling compound to fit closely around the angle of the jaw upon the external surface and by binding this into place with a bandage having a few layers of cotton under it to protect the skin.

Dr. F. A. Green, of Geneva, New York, has devised an appliance which combines an *external dental splint with an interdental one.* Its purpose is to give both external and internal fixation to the lower jaw without the use of bandages. Description of this splint with illustration is published in the *International Congress*, 1904, ii, 183, 184.

Bands or wires which are to be depended upon for securing fractured jaws should not be attached to the teeth immediately upon each side of the fracture, because as a result of the traumatism or subsequent inflammation such teeth are always loosened. Attachment should be made to teeth two and sometimes three teeth away from the line of bone division.

Wiring fractured ends of maxillary bones is occasionally necessary when approximation and immobility cannot otherwise be secured, but this method should be avoided if possible, because opening through the tissues and bone for insertion of the wires gives exposure to infection, and with the wires in place this disadvantage is continued. Incision made through the external surface of the face to expose the bone for the purpose of inserting wire gives still greater opportunity for infection and makes an unnecessary, often unsightly scar. It is practically impossible to pass silver wire as generally used through the jaw bones and twist the ends with sufficient accuracy to give perfect immobility; consequently there is usually more or less motion in segments of the jaw thus attached. Sometimes this is of little consequence, and union takes place apparently without interruption, but in many instances it has led to delayed or faulty union as well as deformity through disarrangement of the parts.

In this connection it must be remembered, however, that there are cases in which suturing of the fractured bones cannot be avoided, because no splint serves the purpose as well. Fortunately these cases are rare, and almost always a dental or interdental splint can be used to better advantage.

The *bandages* generally used for detention of fractures of the jaws are illustrated in Figs. 190 to 193.

Of these the most commonly used is the Barton bandage. The four-tailed bandage is made by splitting a three-inch roll of bandage from each end to a point within two or three inches from the center. The free ends are then applied as shown in Fig. 190.

Patients in whom a bandage such as the Barton, which holds the jaws firmly together, had been applied while under influence of an anesthetic, must be very carefully watched and the nurse or attendant

FIG. 190.—Four-tailed bandage of chin. (Wharton.)

FIG. 191.—Barton's bandage. (Wharton.)

FIG. 192.—Modified Barton's bandage. (Wharton.)

FIG. 193.—Oblique bandage of the angle of the jaw. (Wharton.)

instructed to cut the bandage instantly in cases of vomiting which otherwise might lead to suffocation. Quite serious accidents of this nature have been reported. Usually the application of such bandages during anesthesia may be avoided, and when this is impossible the like-

lihood of danger will be reduced when opportunity is given for proper preparation of the patient before operation and the postoperative hypodermic injections of morphin. But in no case should vigilance be relaxed until the period of danger is over.

Cases in which habitual drunkenness or other reasons make it impossible to keep the patient's bandages in place have been reported by Roe, Marshall, and others. In these the difficulty can be overcome by shaving the head and attaching broad strips of adhesive plaster or a cap of metal or other material, which may be adjusted to the head and the adhesive strips attached without the necessity of shaving the head.

It is unnecessary to describe the manufacture of interdental splints, which is understood by all dentists and fully described in works upon prosthetic dentistry. It seems advisable, however, to call attention to the fact that it is often difficult and sometimes quite impossible to secure a correct impression of a fractured jaw. This can be overcome by the method of sawing through the plaster case secured from such an impression at the line of fracture and adjusting the teeth to correct occlusion with a cast made of an impression of the opposite jaw. In this way an imperfect impression may be converted into a sufficiently perfect one, providing the dental arches were originally reasonably regular in outline.

Once the parts have been firmly secured, the treatment is the same as for other wounds. With compound fractures, care must be exercised to avoid or overcome the results of infection. Harmless, sufficiently antiseptic mouth washes should be used frequently, wound surfaces, if accessible, painted occasionally with tincture of iodin, and close observation given to detect, and, if necessary, to relieve, formation of pus to prevent necrosis if possible. When, by reason of comminution of the parts or otherwise, sequestra of bone require removal, this should be done in the same manner as in other forms of necrosis. Nourishment ought to be suited to the conditions under which it must be taken and as highly nutritive as possible. The bowels must be kept open and generally healthful conditions must be observed.

Repair of Fracture.—When a fracture is properly set the resulting hyperemia is followed by the exudation of lymph which solidifies around the broken fragments and encloses the blood clot and periosteum together with such other tissues as may have been displaced by the traumatism. This becomes vascularized and forms the fibrous tissue of the *provisional callus* during the first week, which eventually becomes calcified and forms the *permanent callus*. The latter ensheaths the bone at points of fracture and serves to give necessary protection until union may take place by more than normal development. In the course of time the callus is absorbed and disappears almost entirely, but a slight thickening along the line of fracture usually remains.

Length of Time Required for Complete Union.—The period during which it is necessary to continue fixation of fractured bones depends:

(1) Upon the situation of the fracture, which is exposed or subject to the action of powerful muscles, requires a longer time for healing than when such adverse conditions are not operative; (2) upon unfavorable constitutional conditions such as debility from old age, long-continued fevers, pregnancy, prolonged lactation, scorbutus, tuberculosis, syphilis, rickets, etc.; (3) upon mobility due to imperfect approximation of the parts or insecure fixation, and complications such as the interposition of foreign substances, soft tissues of the mouth, displaced teeth, suppuration, necrosis, etc.

The time required for union to take place may vary from two weeks and a half, an unusually short time, to several months. Ordinarily five or six weeks are required to give a reasonably good result. But the judgment of the operator must recognize adverse conditions, and in these cases allow the retention appliance to remain in position a sufficient time to make the united fragments self-sustaining.

Delayed Union.—Delayed union may persist for months, and yet, with improvement of the adverse constitutional or other condition, union may take place in natural course.

Faulty Union.—Under unfavorable conditions there may be no perceptible effort at repair, or *fibrous union* may occur by the formation of fibrous tissue between the ends of the bone fragments, which through absorption and rounding of angular surfaces by more or less continued motion sometimes results in a false joint (pseudarthrosis).

In the treatment of united fracture of this character it is necessary to remove the intervening fibrous tissue and to freshen the bone borders, then they must be brought into contact and held securely with a suitable splint or by wiring, as in the case of recent fractures. Pathological constitutional states should receive appropriate treatment to favor the process of bone repair.

Attempts to hold jaw fractures by ligatures or wires around the teeth immediately upon each side of the fracture without other supporting assistance are almost always ineffective, and should not be depended upon as a matter of general practice. Constant movement, because of imperfect fixation, is the chief cause of both delayed and faulty union.

Complications of Fracture.—The trauma which caused the bone lesion may result in serious injury to other parts, or the bone fragments may be forced into or against important structures and cause *laceration of important vessels,* with profuse and even dangerous hemorrhage. Pressure upon a nerve trunk may cause *numbness* or *paralysis. Virulent forms of infection* may be carried into the wound at the time of injury and result in tetanus, septicemia, or other infectious diseases. Double fracture of the anterior part of the lower jaw by action of the digastric, the mylohyoid, and geniohyoglossus muscles allows the part to drop downward and backward with consequent difficult *breathing* or even *suffocation.* Drawing the tongue forward in these cases is not sufficient. Stiffness of the jaw through injury of the glenoid cavity

or fixation for a long period of time may lead to *complete* or *partial ankylosis*. *Necrosis* from infection or comminuted fragments of bone often delay union, and may cause *septicemia* or *pyemia* with quite serious general results.

The most frequently troublesome complication, and one which is peculiar to the jaws and not found in any other form of fracture, consists in abscess and continuance of suppuration from *teeth devitalized* by the traumatism which caused the fracture. These teeth are often quite sound, and if not noticeably displaced give no outward sign of being affected, and yet, over and over again in the author's practice, it has happened that healing processes have been delayed or union prevented by this simple cause. Pus from the roots of these teeth in which the pulps have become gangrenous follows the line of fracture, and no matter what may be done in the way of other treatments, the discharge of pus with corresponding destruction of bone will be continued almost indefinitely. Such teeth should be suspected at once and always sought for in every case of faulty union.

Fractures of the upper jaw very frequently involve the *maxillary sinus*, and when compound or comminuted, one or both antra may become infected. If there be no other cause for continuance of antral disease such conditions clear up in the course of time, and unless necrosis of the bony walls occurs they are not usually followed by chronic empyema.

AFFECTIONS OF THE TEMPOROMANDIBULAR ARTICULATION

Description.—In the temporomandibular articulation the socket is formed partly by the mandibular fossa and partly by the articular eminence, and over the latter an approximately confluent surface for the head of the condyle is formed by the articular disk. The two temporomandibular articulations act simultaneously.

When the mouth is opened the head of the condyle with the interarticular disk glides forward upon the articular eminence, and when the mouth is closed it slips back into the mandibular fossa. The opening and closing of the mouth are consequently attended by a sliding of the mandible (a gliding joint).

In addition to this modified form of hinge movement, the articulation possesses a second kind of motion, the lateral displacement of the mandible in reference to the skull. In this movement one condyloid head remains in the mandibular fossa, while the other advances upon the articular eminence, a movement which is impossible when the mouth is opened to its greatest extent. Both the hinge and the lateral movements are combined in the act of mastication.[1]

[1] Sobotta-McMurrich: Atlas and Text-book of Human Anatomy, i, 118.

Alterations in Form.—As the result of jaw habits the complete or partial loss of teeth, irregularity of teeth and other deformities of the maxillæ, abnormal movement of the mandible results. These, the author believes, often have pathological importance. When the anterior portion of the alveolar ridges is allowed to come in close contact there is more or less disarrangement in the relative situations of the condyles, the intra-articular cartilages, and the coronoid processes. In this way pressure upon nerve trunks is sometimes occasioned and may become an active factor in the causation of persistent pain in the distribution of the fifth nerve. When from habit or necessity there is unusual sliding backward or forward of the mandible or continued lateral movement the result as might be expected is bone absorption through which there is enlargement of the mandibular fossa. Sometimes this is evidenced by more or less reduction of the eminentia articularis and occasionally by absorption of the posterior wall of the fossa. In one of the author's cases this was very marked through abrasion of the anterior teeth and consequent tipping of the anterior part of the mandible upward and forward and tipping of the condyloid processes upward and backward. Constantly applied, more than ordinarily powerful muscles of mastication exercised in the habit of clinching the teeth together caused the heads of both condyles to work backward and upward. This led to extensive absorption of the anterior bony wall of the external auditory meatus and compression of the openings of both external auditory meatuses during closure of the jaws with attendant more or less perceptible deafness. When the jaw was relaxed or the mouth partly opened, the deafness was relieved. Changes in the form of the mandibular fossa and in the heads of the articular surfaces of the condyles bear an important relation to diseases of the teeth and pericementum, particularly interstitial gingivitis or that form which is known as pyorrhea alveolaris. It also accounts for much of the difficulty experienced with artificial dentures. This form of enlargement of the temporomandibular fossa, especially when associated with loss of distinct form and particularly changed outline of the eminentia articularis, accompanied by the general laxity of ligamentous and muscular attachments which is naturally acquired under these conditions, favors dislocation of the mandible in certain individuals. There is unlimited clinical evidence that such alterations in the form and structure of the parts associated in the temporomandibular articulation do occur. Cryer, through his anatomical studies of dried specimens, has added the final proof by calling attention to the more or less frequent evidences of absorption that he has found in both the condyloid processes and the mandibular fossæ.

Dislocation.—Definition.—Dislocation or luxation is defined as displacement of bones at a joint or an organ from its usual situation.

In the surgical sense the term dislocation is used to describe the separation of the articular surfaces of two or more bones entering into the formation of a joint.

Classification.—

Traumatic.—When caused by injury.

Spontaneous.—Any dislocation not caused by external violence (usually pathological).

Complete.—When the articular surfaces are entirely separated.

Simple.—When covered by unbroken tissues.

Complicated.—When accompanied by serious injury to surrounding parts, such as important vessels or nerves, injury to the capsule, or fracture of the bones at the joint.

Primitive.—When the articular surfaces retain their first position after luxation.

Recent.

Single.—When there is one dislocation.

Unilateral.—When a bone situated in such position in the body as to have an articular surface upon each side is dislocated upon one side.

Pathological.—When brought about by disease resulting in destruction of tissues of the joint and displacement by muscular action.

Congenital.—If resulting from prenatal defect or malformation. This form of dislocation is rare and must not be confounded with injury during delivery.

Incomplete.—When only partly separated and some point of contact remains.

Compound.—With an external wound leading to the joint cavity.

Relapsing.—When recurring after a previous dislocation, either because of insufficient time for repair of the parts or through chronic relaxation of the ligaments.

Consecutive.—When still further movement allows a new position of the articular ends of the bones.

Ancient.

Double.—When there is luxation of the same joint in both of two similar bones upon each side of the body.

Bilateral.—When a bone having articular surfaces upon each side of the body is luxated on both sides. Examples of these bones are the inferior maxillæ, the sternum, and the hyoid bone.

Dislocations of the lower jaw are usually intracapsular because of the wide articular capsule permitting dislocation without division of its surface, and therefore *simple* dislocation is the most common form, although both *compound* and *complicated* dislocations sometimes occur from severe injuries.

Incomplete Dislocation.—Through relaxed conditions, one or both condyles may lodge upon the intra-articular cartilage over the eminentia articularis.

Unilateral dislocation describes displacement upon one side only. The dislocation is *bilateral* when it occurs upon both sides.

Forward dislocation is the typical form of dislocation of the lower jaw. But in rare instances there is backward dislocation, in which the articular process glides over the small tympanic tubercle which closes the articular fossa behind and reaches the tympanicostylomastoid fossa[1].

Etiology.—If for any reason the head of the condyle when the mouth is opened passes over the eminentia articularis to a point beyond that from which it can glide backward with normal movement in closure of the jaw, it may become fixed in this position or slide forward over and beyond the articular eminence, to be drawn upward and forward in fixed position by contraction of the masseter and temporal muscles and stretching of the sphenomaxillary and stylomaxillary ligaments. This

[1] Described by Schlatter, von Bergmann's System of Practical Surgery, i, 672.

is a typical form of dislocation of the lower jaw. Abnormality in the form of the mandibular fossa with unusual muscular and ligamentous relaxation to which reference has already been made, would be termed predisposing causes.

The jaws of children are less frequently dislocated than adults, because the eminentia articularis is not so marked and the angles of the rami are obtuse. On the other hand, dislocation among women is much more frequent than among men (according to Krönlein four times more frequent), because of the shallower development of the articulation and the greater tendency to conditions of general health, which predispose to muscular relaxation and the greater tendency to nervous jaw habits, which lead to pathological changes in the fossa.

Direct causes are usually immoderate opening of the mouth, such as in yawning, laughing, states of excitement, screaming, vomiting, the insertion of mouth gags, stretching the mouth open for the purpose of performing dental operations of various kinds, violence, blows upon the side of the face, which usually lead to unilateral dislocation, or upon the chin with the mouth open, which by driving it backward and downward cause bilateral dislocation.

Backward dislocation is caused, according to Thiem,[1] by forcibly closing the teeth, the action of the temporal muscle forcing the jaw backward. Doubtless this would be favored by traumatic force at the point of the chin with the jaw closed.

Pathology.—When the joint capsule is relaxed or the surrounding muscles and ligaments have lost their activity, through paralysis or otherwise, dislocation may take place without laceration of the synovial membrane. When, however, dislocation occurs under normal conditions from some unusual force, there may not only be laceration of the capsule, but involvement of the surrounding and associated bone and soft tissues. Hemorrhage and inflammatory conditions naturally follow with resulting exudate and the formation of connective tissue, which in reduced dislocations in the course of time render their reduction exceedingly difficult or impossible. Through infection the integrity of the glenoid cavity or the condyloid processes may be more or less completely destroyed by suppurative processes.

Symptoms.—Forward dislocation of the mandible gives a general picture of distress, but the explanation of the symptoms is obvious (Fig. 194).

In *bilateral forward dislocation the mouth is widely opened;* with the *lower jaw fixed* in this position, the *lower teeth project* beyond the line of the upper, there is *abnormal flow of saliva, and a distinct depression at the glenoid cavity,* in front of the tragus; the head of the condyle can be felt beneath the malar bone, and the coronoid processes felt from within the mouth are found to be displaced forward under the zygoma. *Marked muscular contraction* may be accompanied by *pain.* The

[1] Von Bergmann's Bulletin, p. 672.

fixed position of the jaw interferes with speech and prevents use of the jaws in mastication or otherwise. *Unilateral dislocation* is marked by similar symptoms upon one side only with the chin displaced toward the unaffected side.

As previously noted, this is distinguished from unilateral fracture of the neck of the condyle, because in this form of fracture the chin and jaw are pulled toward the injured side. In the course of time pain ceases to be troublesome, and if the dislocation is not reduced a certain amount of free movement is acquired through loosening of the capsule. In *backward dislocation* the teeth of the lower jaw rest behind those of the upper, and the condyloid process can be felt beneath the external auditory meatus in front of the mastoid process.

FIG. 194.—Bilateral dislocation of the lower jaw. (Hamilton.)

Diagnosis.—The symptoms as described are in most cases recognized without difficulty. Confusion could only occur through some complicating condition or in backward dislocation, and in cases of this character the *x*-rays are a valuable aid in determining the exact situation of the parts.

Treatment.—To make reduction of a dislocated lower jaw, stand in front of the seated patient, and, with thumbs well wrapped for protection, placed upon the lower molar teeth upon each side of the dislocated jaw, make pressure downward and slightly backward, at the same time lifting the chin upward with the other fingers. In more obstinate cases pieces of wood or cork may be placed between

the molar teeth, and standing behind the patient, whose head rests against the operator's chest, with hands clasped under the chin, force is exerted to draw it upward. It is sometimes necessary to give a general anesthetic to cause muscular relaxation. In irreducible or chronic cases the removal of the coronoid processes or operations upon ligaments have been recommended, but conditions calling for such radical treatment are exceedingly rare, and the results undoubtedly more or less uncertain. In *unilateral dislocation* the treatment above described is applied to the affected side and simultaneously an additional effort to force the chin toward the median line. *Backward dislocations* are reduced by forcibly opening the mouth or by pressing the lower jaw backward, then downward and forward, under anesthesia. The after-treatment in all forms of dislocation of the mandible is to limit or control its movement, to prevent tendency to recurrence until after the parts have had opportunity to recover. Usually this requires ten days and sometimes longer. Food should therefore be such as to require slight movement of the jaw, if any, and highly nourishing in character. *Recurrent* dislocations are often very troublesome (Fig. 195).

FIG. 195.—Reduction of dislocation of lower jaw.

Chronic Dislocation of the Jaw.—C. Riley[1] reports the case of a young woman whose jaw became constantly dislocated when talking and laughing after having been dislocated for the first time in a dentist's chair. She was relieved by an appliance which is illustrated (Fig. 196). It is described as follows:

"A piece of German silver wire was bent so as to fit across the top and sides of the head and extend down toward the zygoma and over the joint on each side. On the inner side of each end there was riveted a plate about three-quarters inch in diameter, which was padded with piano felt and covered with kid. The wire was bent so as to make firm pressure over and slightly below the joints. This acted in retaining reduction, enabled her to eat solid food in a short time, and ultimately to do away with the apparatus."

[1] Am. Jour. Orthop. Surg., April, 1908.

Imperfect dislocation or *subluxation of the lower jaw* Marshall[1] describes as a condition in which the condyle partially slips from the glenoid fossa in a forward direction, and in front of the interarticular cartilage, when the mouth is opened. Upon closing the mouth the condyle goes back again to its place with a clicking, snapping sound. Sometimes it catches for a moment when the mouth is widely extended and causes anxiety on the part of the patient for fear that the jaw is dislocated.

Pathology.—The pathology consists in alterations of the mandibular fossa and relaxation of the surrounding ligaments as previously described.

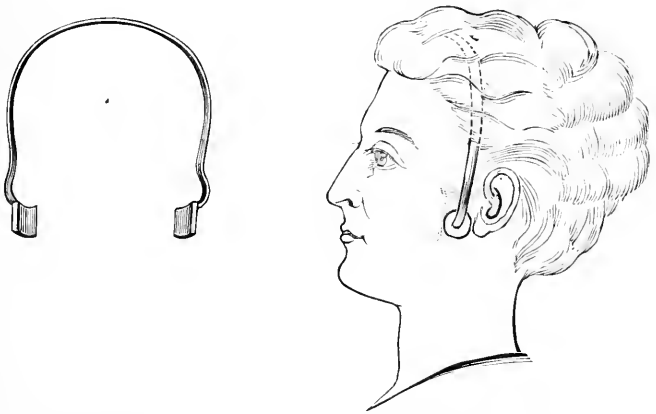


FIG. 196.—Riley's appliance for chronic dislocation of the lower jaw.

Treatment.—No treatment is required except in rare instances when reduction cannot be accomplished by the patient without assistance. If very annoying, temporary fixation of the parts may assist in stiffening the parts surrounding the articulation and decrease the likelihood of its recurrence.

Arthritis.—The temporomandibular articulation is subject to the same inflammatory affections as other joints. Inflammations limited to distinct parts are described as *chondritis*, when affecting the cartilage; *synovitis*, the synovial membrane; *parasynovitis*, the joint capsule and ligaments; and *panarthrosis* when all parts are involved.

These terms are of little clinical value, because in acute inflammations almost invariably all of these structures are involved together. In rare instances, however, some one of them may be affected by a low-grade chronic inflammation without necessarily involving the associated parts. Surgical affections usually begin in the synovial sac as *synovitis*.

The temporomandibular articulation is not as frequently exposed

[1] Injuries and Surgical Diseases of the Face, p. 254.

to traumatic and other injuries as many other joints in the body, and inflammations beginning in the joint cavity are comparatively rare, and further, because it is the results of such inflammations that the surgeon is chiefly called upon to treat. For the sake of brevity and practical advantage the pathological conditions leading thereto will be described in relation to their effect in limiting the free movement of the joint.

Synovitis.—Classification.—

Primary.	Secondary.
Acute.	Chronic.

Etiology.—Causes are traumatic injuries, affections of the synovial membrane or articular cartilages, foreign bodies in the joint, and inflammatory process due to the foregoing causes or bacterial or chemical irritants in the circulation. The *general causes* include diseases due to faulty metabolism, rheumatism, gout, and infectious diseases, such as influenza, pneumonia, typhoid, and scarlet fevers, gonorrhea, syphilis, etc. *Neuropathic* influences manifest themselves as causal factors in spinal and other nerve affections.

Pathology.—The disease may be *monarticular* (affecting one joint or *polyarticular* (affecting more than one joint). Its first manifestations are usually in the synovial membrane. As a result there may be a decrease of serous secretion with exudate having a tendency to coagulate—*dry synovitis* (synovitis sicca). In *acute synovitis* there is usually more or less effusion. If this becomes infected it is known as purulent synovitis and in chronic synovitis in the absence of pus the serous effusion is called *hydrarthrosis*. Such effusions naturally cause distention of the synovial membrane, with such changes in the structures of the joint as their character would indicate.

Symptoms.—The symptoms consist in more or less loss of motility, pain, and swelling. In chronic forms there may be deformity, as in arthritis deformans, complete ossification of the joint, as in osteoarthritis, or the destructive processes of caries and necrosis.

Treatment.—Treatment must be so directed as to overcome the cause and relieve the local symptoms, with a view to prevent stiffening of the joint. With reference to the lower jaw this is as described in treatment of temporary ankylosis, page 368.

Ankylosis of the Jaws.—While the following classifications are applicable to ankylosis of the temporomandibular articulation in common with the other joints, the following distinctions require special consideration in this region:

Classification.—

Temporary.	Permanent.
Fibrous.	Bony or true ankylosis.
Unilateral.	Bilateral.

Murphy[1] states that ankylosis is a generic term and does not repre-

[1] Jour. Am. Med. Assn., May 20 and 27, and June, 1905.

sent a pathological entity. His classification of ankylosis and the types of arthritis which lead to ankylosis are as follows:

- Ankylosis, true and false
  - Peri-articular
    - Capsular
    - Extracapsular
      - Tendinous.
      - Tendovaginal.
      - Muscular.
  - Articular
    - Synovial.
    - Cartilaginous.
    - Osseous.
- Arthritis
  - (*a*) Primary hematogenous fibrous arthritis.
  - (*b*) Dry fibrous arthritis non-traumatic.
  - (*c*) Traumatic fibrous arthritis
    - With fracture into the joint
    - Without fracture (contusion).
  - (*d*) Suppurative
    - Hematogenous
      - Cryptogenetic.
      - Metastatic
        - Typhoid.
        - Scarlatina.
        - Pyemia.
        - Gonorrhea.
      - Traumatic.
    - Extension
      - Osteitis
        - Tubereulous.
        - Osteomyelitie (infective)
      - Peri-arthritis (phlegmon).
      - Panarthritis.
  - (*e*) Ossifying arthritis (primary).
  - (*f*) Static adhesive.

Temporary Ankylosis.—Etiology.—Temporary ankylosis is due to inflammatory conditions of the tissues surrounding the temporomandibular articulation, which may be in the nature of an acute synovitis or stiffness and contracture of the surrounding muscles, spasmodic muscular contraction due to direct irritation of the third division or of the trigeminal nerve, which, however, must not be confounded with the trismus of tetanus; parotitis or inflammations of other glands in this region, both salivary and lymphatic; tumors, traumatic injuries, and infections of any kind which may affect the joint structures or surrounding parts without creating permanent injury.

Pathology.—The most frequent causes of temporary ankylosis are malposition and delayed eruption of the third molar teeth with attendant inflammatory processes and dento-alveolar abscess in the same region. As the mandible develops, unless the third molars are allowed to progress upward in the natural course of eruption, it quite frequently happens, as the growth of the roots proceeds, that the extension finally reaches the inferior dental canal. This occasions more or less direct pressure upon the third division of the fifth nerve, and in this way irritation may occur which can be a factor in causing muscular spasm or in leading to pain which may give rise to inflammatory processes, especially when supplemented by infection.

Dento-alveolar abscess and other infections, tumors, and swellings which restrict or obstruct jaw movement do not differ in their pathological manifestations from similar conditions in other parts.

The pathology of acute synovitis has already been described (p. 366).

Symptoms.—The symptoms are usually those of acute inflammatory conditions when the restricted movement of the mandible appears to be merely incidental to other troublesome symptoms.

Prognosis.—The prognosis in these cases is good, providing relief can be given before permanent changes in the tissues have been allowed to take place. Usually the symptom of jaw stiffness disappears in the course of time, but occasionally efforts to open the mouth forcibly must be continued for a considerable period to prevent the formation of adhesions.

Treatment.—Treatment consists of applications to reduce the swelling, removal, or prevention of local infection and separation of the jaws when necessary with mouth gags or movement otherwise enforced if possible. When impacted third molars are the cause, and there is infection in the surrounding and overlying gum and cheek tissues, good judgment must be exercised in deciding between immediate removal of the impacted molar, through which complete relief might be expected, or palliative treatment for the control of the acute infectious condition before exposing the individual to general infection by allowing the pus microörganisms directly to enter vessels which must be unavoidably lacerated in removal of the tooth. A number of deaths have been reported from this cause. When the presence of pus in considerable quantity seems to indicate danger in this direction it is usually the part of wisdom to force the mouth open with suitable mouth gags, even though an anesthetic may be required on account of the acute pain. They should be kept apart with corks between the teeth so as to permit proper cleansing and treatment of the inflamed tissues in the angle of the jaw.

When the acute infectious symptoms have sufficiently subsided, removal of the impacted tooth may be safely performed. Even after removal it is sometimes necessary to continue the processes of more or less forcible openings of the jaws in order to prevent adhesions in and around the joint which might lead to more or less permanent ankylosis. If there is synovitis, with marked evidence of effusion, which necessitates relief by division of the synovial capsule, this should only be done as a last resort and under the most careful aseptic precautions to prevent carrying the infection into the joint. Of course, when pus has already formed in this situation its free evacuation is demanded.

Fibrous Ankylosis.—Fibrous, false, or pseudo-ankylosis as noted by Park is more properly a contracture.

Etiology.—Fibrous, or false, ankylosis is caused by the formation of fibrous tissue within the joint intra-articular or extra-articular, cicatricial or fibrous bands constricting the ligaments or muscles concerned in the movement of the joint, and the structures immediately surrounding it. These may be the result of synovitis and arthritis due to syphilitic or other destructive process following infectious diseases, extensive burns, ulcerative processes within the mouth, as ulcerative stomatitis, necrosis of the jaws, gangrena oris, and similar affections.

Pathology.—Intra-articular adhesions are the result of synovitis and arthritis in which the exudate has become organized and has caused the formation of fibrous tissue within the joint or the formation of osteophytes which interfere with free movement. In extra-articular conditions the cicatricial and fibrous bands are formed in the course of healing of extensive injuries, ulcerations, and gangrenous or inflammatory processes which mechanically bind the parts. These may be in the ligaments surrounding the joint or in the muscles of mastication or both.

Symptoms and Diagnosis.—The symptoms consist in *fixation of the jaw*, but this is usually susceptible of slight motion, which serves to distinguish it from true or bony ankylosis, for in such cases movement is impossible.

Arrested development of the lower jaw with marked recession of the chin is a notable feature when fixation of the jaw has occurred at an early period of life. It is not always possible to determine whether the ankylosis is unilateral or bilateral, but in the author's experience the center of the chin being more or less noticeably upon one side of the central facial line[1] indicates that the jaw has been drawn toward the affected side and that loss of development has been more marked on that side. Therefore it is fair to assume that the affection is chiefly unilateral, for it must be remembered that although the lesion that caused the ankylosis may originally have been confined to the temporomandibular articulation upon one side, fixation of the jaws during a long period of time might be expected to cause more or less permanent impairment upon the opposite side. In all of the author's cases, four of which are referred to in the following descriptions, this simple diagnostic feature has served to point the way to successful diagnosis.

Prognosis.—The prognosis in these cases depends entirely upon the successful continuance of the effort to keep the jaws open. The contraction of scar tissue following such operations continues for a very long period of time, and it is not sufficient to continue extension during the healing of the wound only. The muscles must be stretched by forcing the jaws open, and this treatment continued for a period of time sufficiently long to make certain the permanency of the results.

Treatment.—When the fibers or cicatricial bands which hold the jaw in fixed position are confined to one side and are so situated that ankylosis would persist even though the jaw were free at the articulation.

Such cases may be treated by severing the restricting bands of tissue from within the mouth; continued separation of the jaws by the use of a mouth gag until the necessary freedom of movement has been secured; continuance of this movement and prevention of reformation of the adhesive-tissue bands and contracting muscular factors by keeping the mouth permanently and continuously open and the jaw in free movement until there appears to be no likelihood of recurrence

[1] An imaginary line, referred to elsewhere, taken from the central portion of the forehead perpendicularly down through nose and chin.

of fixation. The author has had many satisfactory results in the treatment of unilateral fibrous ankylosis by the intra-oral operation as described in the following cases from his own practice.

The history of such treatment as generally practised has been unsatisfactory, but chiefly so for the reason that the proper measures for continuous jaw movement have not usually been instituted. When this has been done there has been failure to continue for a sufficiently long period. Nevertheless in spite of every care in the effort to continue the free movement of the jaws, it may be impossible to overcome the tendency to restricted motion. This is indicated by the complete history of the child shown in Fig. 200 and again in Fig. 202. The development of the molar teeth in this case led to conditions which caused recurrence of the jaw fixation, long after complete success seemed to have been assured.

FIG. 197.—Child, aged two and one-half years, with ankylosis of the lower jaw from the day of birth. The receding chin shows the typical arrested development of the mandible.

FIG. 198.—Same child as shown in Fig. 197. The chin is drawn to the left, the side that was found to be affected by fibrous ankylosis.

Figs. 197 and 198 illustrates a little girl, aged two and one-half years, with ankylosis from birth. No instruments were used in delivery, but the mother was a number of hours in labor and there was without doubt some injury to the jaw by reason of this fact. From this case and other similar ones that the author has seen it seems to him fairly certain that ankylosis of this character is brought about by backward dislocation of the jaw through some traumatic injury during labor. It is interesting to note by way of emphasizing the value of the simple diagnostic signs, that eighteen different medical and surgical practitioners had examined this child without being able to determine whether the affection was unilateral, bilateral, fibrous, or bony. Diagnosis was made of fibrous ankylosis because there was slight but distinct movement of the jaw upon manipulation. The chin, as will be noted,

is upon one side of the central facial line. Therefore it was believed to be unilateral. At the time of operation this proved to be correct. The child was given a general anesthetic, and with complete relaxation a thin, flat instrument was passed between the teeth. By continued application of steady force it was then possible to slip an ordinary mouth gag, with the flanges filed down so as to leave two flat surfaces to slide between the teeth, in through the space caused by the overbite of the upper jaw projecting beyond the undeveloped lower jaw. This permitted the passage of the blade of a knife and a blunt instrument to be used as a director through which the most prominent fibrous bands were located and then severed. With each incision there was a noticeable improvement in opening the jaw, and with continued pressure it was finally possible to pass a finger into the mouth between the teeth. With this as a guide the knife could follow until all of the restricting bands of tissue were cut and the jaw opened to its full extent. Every movement indicated without question that there was no serious obstruction upon the opposite side. The teeth should first be protected by a metal or other plate, to prevent injury from the gag.

Postoperative Treatment.—It must be recognized: (1) That the jaw must be kept continuously open or in free movement for a long period of time; otherwise there will be recurrence and a condition probably worse than before the operation. (2) Unless the jaws are kept widely open both day and night, the healing process during the sleeping hours will more than overcome what might be accomplished during the daytime. (3) That any kind of an appliance which a young child would be likely to fear would cause so much disturbance and difficulty, perhaps fighting and struggling in efforts to keep it between the jaws, that it would be unreasonable to expect parents to carry on such methods regularly and continuously for a sufficiently long period of time.

To meet these requirements the author employs a very simple expedient which has been useful in many similar and large numbers of other kinds of cases in which it was necessary to keep the jaws open. The device consists of a series of rubber corks, to which for safety several inches of string, ligature, or cord have been firmly attached to prevent accident in case one might slip into the throat and be swallowed. The smallest size of these can be readily slipped between the teeth and gradually forced backward without frightening, giving pain or other serious inconvenience to the child. A larger size can then be inserted on the opposite side of the mouth and gradually forced back in the same way. Continuing from one side to the other the fourth or fifth larger cork can finally be placed between the teeth. Any reasonably disciplined child can be induced to keep a cork of that kind constantly in the mouth, for it gives practically no inconvenience. The little girl whose case is described used to amuse herself and play with her dolls with the cork between the teeth without any trouble whatever, and slept with the jaws in the same situation. Thus they were kept con-

tinuously apart for many months, and even now, after a lapse of several years, the mother continues to stretch the parts occasionally in this way. Improvement in the shape of the face and the lower jaw with

FIG. 199.—Child shown in Figs. 197 and 198, with cork between the jaws as described.

FIG. 200.—Result of operation for fibrous ankylosis. Same child as in Figs. 197 and 198.

FIG. 201.—Shows the scar of the external operation for ankylosis about three weeks after operation. The hair that was shaved above the flap will almost entirely cover the defect when grown again, and the scar will be much less noticeable in all respects.

FIG. 202.—Same girl shown in Fig. 201 after operation. Previously there was almost complete fixation of the jaws.

almost complete free movement has been the result. Figs. 199 and 200 are pictures of the same child, shown in Figs. 197 and 198, with the cork in place as described, and after operation.

The eruption of the molar teeth backward, toward the angle of this typically short mandible, created conditions which brought about a more or less gradual limitation of movement until finally, about the

FIG. 203.—Unilateral fibrous ankylosis; chin drawn toward the affected side.

FIG. 204.—Same girl shown in Fig. 203, attempting to open her mouth.

FIG. 205.—Picture of the same girl as in Figs. 203 and 204, opening her mouth after operation.

age of thirteen years, the ankylosis was again complete. An attempt was again made to force the jaws apart under anesthesia, but it was found impossible to do this without serious injury to the teeth. It

therefore became necessary to do the external operation according to Murphy's method, the result of which is shown in Figs. 201 and 202.

Figs. 203, 204 and 205 show a little girl for whom the intra-oral operation was performed for unilateral fibrous ankylosis, resulting from aural disease. It will be noticed that beginning at a later period there is not the same amount of recession of the chin, because the lower jaw has developed normally until the beginning of the trouble. The diagnosis of unilateral affection was made from the fact that the chin was upon one side of the central line, and it was found to be correct, for free movement was secured immediately upon separation of the restrictions upon the affected side. Fig. 206 is a skiagraph of the case illustrated in Figs. 203, 204 and 205.

Fig. 206.—Skiagraph of a case of fibrous ankylosis. The same one illustrated in Figs. 203, 204 and 205.

Bony Ankylosis.—Etiology.—Bony ankylosis results from a distinctive type of arthritis, which may be due to any one of the diseases that may cause the latter affection, particularly such as are accompanied by suppurative processes. It may also be brought about by calcific changes such as occur in osteo-arthritis or result from traumatic injuries which may destroy the integrity of the parts and lead to infection. Roe believes that bony ankylosis resulting from such injuries is always accompanied by fracture. In the author's experience a quite common cause of both true and false ankylosis is the extension of suppurative aural diseases. The case illustrated in Fig. 207 with bilateral

ankylosis began after extensive suppuration, which affected the ear upon one side and later upon the other. Others of the author's cases have given a similar history.

Symptoms.—Absolute immobility of the lower jaw is the dominant symptom. In cases where the affection has begun at birth, infancy, or early childhood there is arrested development of the lower jaw, which remains approximately the size that it was at the period of onset of the affection. There is corresponding recession of the chin and lack of development of the lower part of the face, with marked projection of the upper jaw. This is fortunate for the patients, as it enables them to pass food through the mouth and to secure sufficient nourishment without movement of the mandible. Contrary to expectation, the general health and appearance of these individuals is usually fairly good. Figs. 208 and 209 are radiographs of adults with bony ankylosis.

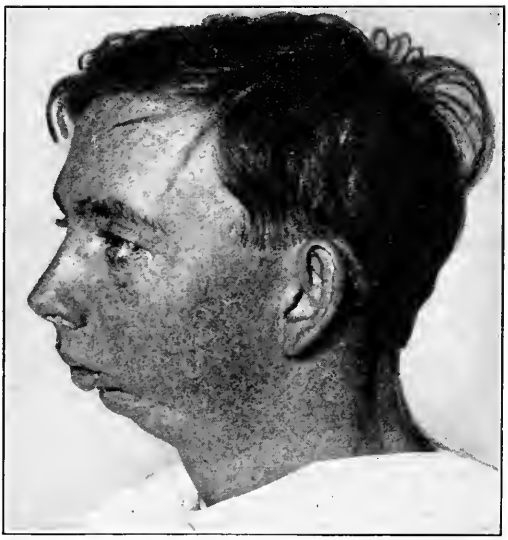


FIG. 207.—Bilateral bony ankylosis.

Prognosis.—In operations for the relief of bony ankylosis the chief danger lies in asphyxia. Usually the cases that prove troublesome in this respect are also those in which there has been difficult breathing before operation was performed, and from this history the operator may be on guard. Safety depends upon readiness to meet the situation both during and after the operation. The result necessarily depends very largely upon the character of the cause and the actual condition of the ankylosis. If operation upon the condyles can give sufficient movement without restriction from anterior attachments, then a good permanent result may be expected. If such bands exist and the condition is unilateral, there will be sufficient force in mastication from the muscles of the unaffected side to overcome disadvantage of the

loss of functionating power upon the side from which a section of the jaw has been resected. When, however, the ankylosis is bilateral and

FIG. 208.—Radiograph of an adult with bony ankylosis.

FIG. 209.—Radiograph of an adult with bony ankylosis.

of such character as to make it impossible to give relief by operating upon the condyles, resection according to the Esmarch operation upon

both sides leaves little or no muscular strength for use of the jaw in mastication. If such patients are well nourished and getting on comfortably without operation, it is the author's belief that they should be left undisturbed, for bilateral Esmarch operation ought not to be performed except in rare cases of urgent necessity.

Treatment.—The purpose of all methods of treatment of bony ankylosis is to establish a pseudarthrosis. Among the various operations devised for this purpose are the following: *Removal of a segment from the body of the jaw* near the angle, already referred to as Esmarch's operation; *division of the ascending ramus*, as recommended by Dieffenbach; separation of the jaw by *cutting with forceps used from within the mouth* anterior to the cicatricial band causing fixation as recommended by Rizzoli; many variations of the three preceding operations, as suggested by Elliot and Cabot, of Boston, Whitehead, of Manchester, and others; *removal of wedge-shaped sections from the ramus* and the *insertion of gauze or gutta-percha tissue, muscle*, or other tissue or *skin* to prevent reuniting of the parts, as recommended by McIlhenny and Gluck, of Berlin, who implanted a cutaneous wedge with attachment to the bony surfaces to prevent union; *excision of the head and neck of the condyle*, first performed by Humphrey in 1856; and *removal of a section of the jaw in front of the fibrous bands.*

Excision of a section from the neck of the condyle without removal of the head and then insertion of a flap of tissue. This operation was perfected by the late Dr. John B. Murphy.[1] Modifications of his method which are now generally followed with much success by many operators are illustrated in Figs. 210–213. The incision is L-shaped, the perpendicular portion comes down to the upper border of the zygoma and then extends forward for one-half to three-quarters inch, making the longitudinal portion. This incision leaves a very slight scar, and gives better access than does the perpendicular incision, because in some of the cases the ankylosis extends forward on the zygoma from the glenoid to the coronoid process. The perpendicular incision is for securing the fat and fascia of the temporal muscle.

For dividing the ankylosis the chisel is more satisfactory than the bur. The greatest caution is required in the use of the chisel or the bur, because the brain is separated by a very thin plate of bone only.

After the incision the edges of the wound are retracted, the lower lip being displaced down over the lower border of the zygoma, to give a good exposure of the joint. Then the tissues are separated with a special curved periosteotome all around the anterior surface of the line of union and further separated with a similar instrument around the posterior surface. When the bone is laid bare, the instruments are passed behind the neck of the bone, one from each side; when they are in place they completely encircle the neck, holding the soft parts retracted so the articulation is fully exposed. The insertion of these

[1] Practical Medicine, Series 11, 1915.

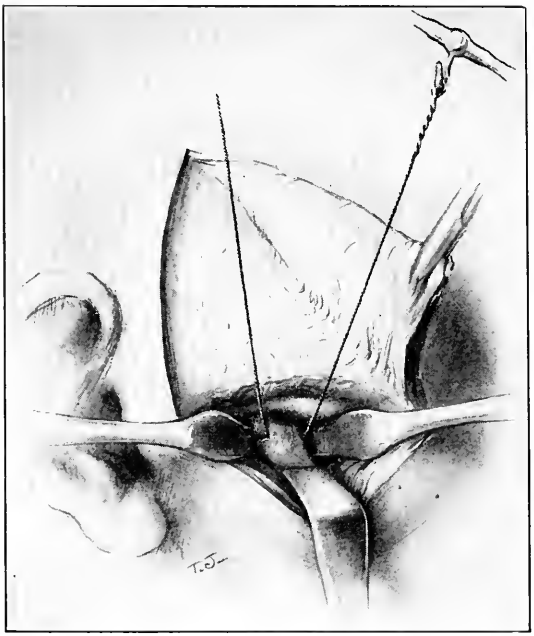


FIG. 210.—The Gigli saw used to divide the mandible.

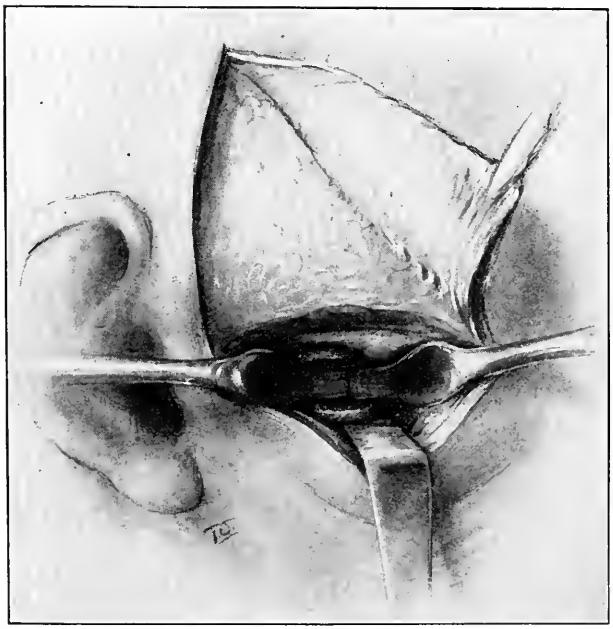


FIG. 211.—The gap left after the exsection, with the curved periosteotomes still *in situ.*
FIGS. 210 and 211.—Arthroplasty for intra-articular ankylosis of jaw. (Murphy.)

FIG. 212.—The temporal fascia and fat flap freed and prepared for insertion.

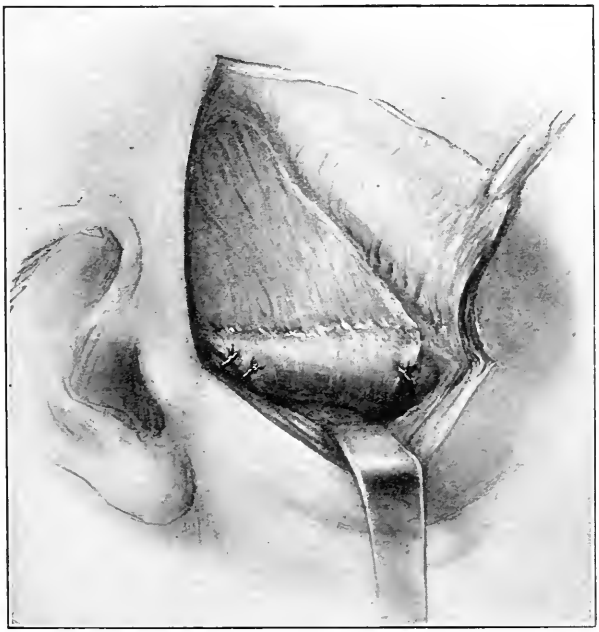


FIG. 213.—The temporal fascia and fat flap secured in its interposing position by sutures.
FIGS. 212 and 213.—Arthroplasty for intra-articular ankylosis of jaw. (Murphy.)

instruments and their retention during excision form the key to the success and safety of the operation. Injury to the internal maxillary artery, which closely hugs the neck, is thus avoided. The chisel or bur then divides the bone on the level of the tubercle, without endeavoring to remove the articular surface of the head of the bone, as there is

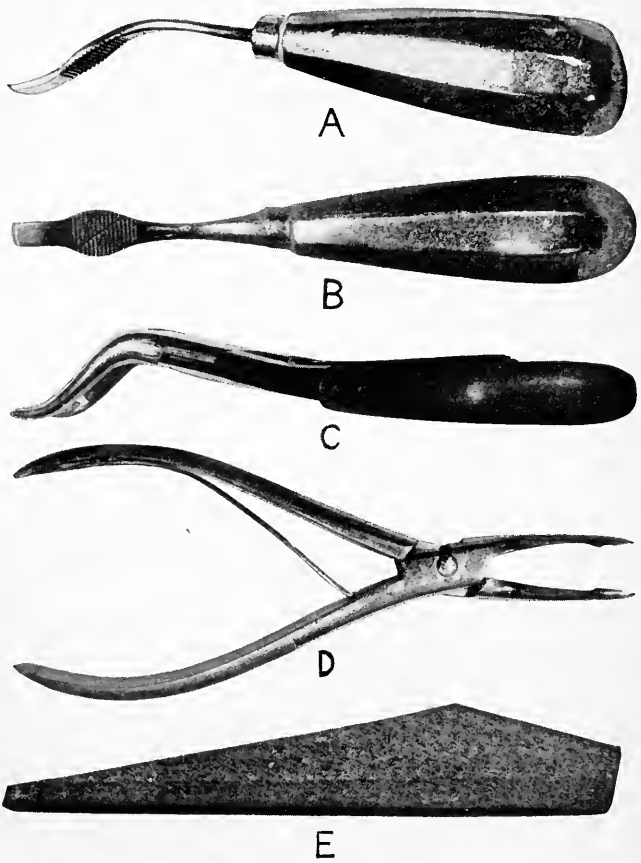


FIG. 214.—Arthroplasty for intra-articular ankylosis of jaw. (Murphy.) *A*, *B*, Dr. Murphy's periosteotome, side and back view (somewhat reduced); *C*, *D*, bone-cutting forceps or nippers, side and front view (somewhat reduced); *E*, the interdental block designed by Dr. Murphy to maintain the desired spread of the jaws. It is made of wood, and since it is wedge-shaped the degree of opening can easily be regulated by withdrawing or pushing in the block.

danger of penetrating the base of the skull when an effort is made to excavate all of the head. If bony ankylosis is present, one-third inch of the neck is excised, so one can put the tip of the finger between the divided fragments across the space over the inner margin of the neck at the base of the zygoma. This must be done carefully, and ample bone removed, so as to admit the interposing flap. The periosteum

should be left attached to the bone that is removed. The deeper fragments of bone can be taken out with a small ronguer. If one desires, as soon as the periosteotomes have been passed behind the neck of the bone, a small and full-curved aneurysm needle may be used to carry a silk thread around the neck to act as the carrier for the Gigli saw; this method is rapid and effective. The difficulty of inserting the saw is slight, but the acute angulation which necessarily occurs, occasionally causes it to break, giving some inconvenience. On the whole, it is not handled as easily as the chisel. As soon as the bone is completely divided, the mouth can be opened readily by the anesthetist.

The interposing flap should now be prepared. The perpendicular incision is elongated up, say for one and one-half inches over the temporal muscle, about three-quarters inch wide and one and one-half inches long, leaving the base attached to upper margin of the zygoma. This is freed from above down, folded down over zygoma and packed into the bony gap, from which a portion of the neck has been removed. At its anterior and posterior basal angles it is securely tacked, with a few catgut sutures, to the fascia and periosteum, so as to retain it in position. Then the skin is accurately closed with horsehair, dusted with bismuth subiodide and sealed with collodion gauze. No other dressing needs to be applied.

No special effort should be made at this time to spread the jaws, as it is important the lower jaw should remain steadied on the well side in order that the wooden block inserted on the diseased side may maintain the wide separation of the molar teeth, until the interposing flap has healed in. This block also prevents compression and necrosis of the flap.

Babcock transplants fat from some other portion of the body into the space between the ends of the bone. This saves the necessity for the perpendicular incision. Dr. Morris I. Schamberg, of New York, recently exhibited a very successful result, although he placed no tissue between the bone ends in that case. The author has found it easier to insert the flap of fascia as described by Murphy, and although Murphy's instruments, as shown in Fig. 214, would undoubtedly facilitate the accomplishment of the operation, he has found little difficulty in securing the desired results with quite simple instruments, devised to meet the operative requirements.

Roe's description of the operation for excision of the head and neck of the condyle in the report of one of his cases is valuable. He says:[1]

"I made an incision opposite the neck of the condyle, beginning just below the zygoma and extending downward one and one-half inches. The anterior border of the parotid gland was next retracted backward, exposing the masseter muscle. With the blunt-pointed dissector I separated the fascia and fibers of the masseter muscle and periosteum about opposite the middle of the skin incision forward,

[1] National Dental Association, 1902, pp. 92 to 94.

dilating this opening with forceps until I could introduce my two index fingers. Through this opening I made a subperiosteal excision with a chisel of the mass of callus, including the condyle and neck, and found that the bridge of bone connected the outer surface of the head and neck of the condyloid process with the outer surfaces and lower border of the posterior portion of zygoma, and was about one-third of an inch in thickness and three-quarters in width. There was no union between the articular surfaces, and an apparent absence of the interarticular fibrocartilage. After clearing the lower border of the zygoma and making smooth the excised border of the ramus, I was able to pass my index finger freely between the ramus and glenoid fossa, and could spread the mandible sufficiently to demonstrate that it was free upon that side, except for its muscular attachments. After carefully flushing with water to remove any chips of bone, I brought together the separated fibers of the masseter muscle and fascia with catgut sutures, afterward closing the skin wound with Halstead's subcuticular suture, using silkworm gut. (Gregg has recommended closing the wound without drainage.) The same procedure was repeated upon the left side, and almost precisely the same condition of the articulation was found. As soon as the section through the neck of the condyle was complete, the mandible dropped a little distance. When I had completed the excision, and before closing the wound, I placed an ordinary mouth gag between the teeth and opened the mouth to about the normal extent, and then by grasping the mandible I made some lateral manipulations, after which the wound was closed.

"There was no special interference with respiration during either operation, and the patient made a rapid and uninterrupted recovery from each. The wound healed by primary union, and in each case the sutures were removed on the eighth day. He was allowed to open his mouth as freely as the bandages would permit, and ten days after the second operation, when he left for his home, he could voluntarily separate the anterior teeth to the extent of one inch, and was learning to masticate solid food. Three weeks later he could open his mouth one and one-fourth inches. There was paralysis of the muscles supplied by the malar and infra-orbital branches of the temporofacial division of the seventh nerve, from which he gradually and almost completely recovered in two months. He has actively exercised the muscles connected with the mandible, and at the present time can open his mouth one and one-quarter inches, can close it with about as much force as the ordinary person, and has good lateral motion."

In describing other cases, Roe calls attention to one in which a tracheotomy was necessary to overcome arrested respiration when the mouth was opened after the jaw had been freed from its attachments. He reports the case of another patient who died from arrested respiration almost without warning after he had been returned to his room in the hospital apparently in good condition. In this case local anes-

thesia was used because of the danger apprehended from a general anesthetic. Dr. Wayne Babcock, of Philadelphia, also reports one case in which death occurred quite unexpectedly after the patient had been returned from the operating room.

Roe believed that through absence of development of the mandible in these individuals the hyoid bone is not raised to its proper position, and that it is displaced backward and downward, causing displacement of the organs dependent upon it. Thus it leaves very little pharyngeal space, and when the mandible is freed from its attachment and drops to some extent, the base of the tongue and the posterior surface of the larynx lie in apposition to the posterior pharyngeal wall. Thus respiration is difficult or impossible.

Esmarch's Operation.—An incision about two inches in length is made along the lower border of the jaw. The bone is exposed, the periosteum divided, and a wedge of bone with its base below removed from the body of the jaw anterior to the masseter muscle and in front of the contracted tissue, bleeding checked, and the wound closed. Passive movements must be begun as soon after the operation as practicable and continued regularly. Corks between the teeth to keep the mouth open as widely as possible should be employed as already outlined for fibrous ankylosis. It is only under very rare conditions that this operation might be required.

Postoperative Treatment.—The jaw must be firmly secured to prevent its dropping and causing suffocation until such time as the patient may have quite recovered from the anesthetic and has had some opportunity to become accustomed to new conditions in respiration. At a later period and before adhesions have had opportunity to become sufficiently resistant, motion of the jaw should be instituted and continued until a permanent result is secured. In other respects the treatment of these patients is the same as for other operations subject to more than ordinary care in administering nourishment under the difficult conditions that are imposed.

Arthrodesis.—This term is applied to the intentional production of ankylosis in a joint previously healthy or nearly so with the intention to stiffen and enhance its usefulness. This is usually required in cases of infantile paralysis with loss of control of the extremities. It is also in a measure applicable to cases of too free movement of the condyle in the temporomandibular fossa from habit, relaxed conditions of the ligaments and muscles, when temporary immobility of the jaws is secured or other methods of fixation for the purpose of gaining a measure of stiffness in motion, and it is undoubtedly upon this principle that the various expedients for jumping the bite are enabled to operate successfully.

In other parts arthrodesis is sometimes brought about by opening into the joint itself to stiffen more firmly than might be expected from less heroic methods.

RESECTIONS OF THE JAWS.

The purposes of resection of the maxillæ are for removal of the malignant growths, correction of deformities, and, as already described, the formation of a false joint in treatment of ankylosis. In addition to this, large sections of bone involving the entire thickness of the body of the jaw are sometimes removed as sequestra in the treatment of necrosis.

Resections of the Lower Jaw.—The several forms of resection of the lower jaw are as follows:

Temporary, when the jaw is resected to facilitate the performance of some operation in the mouth or pharynx and immediately closed as illustrated in Fig. 215.

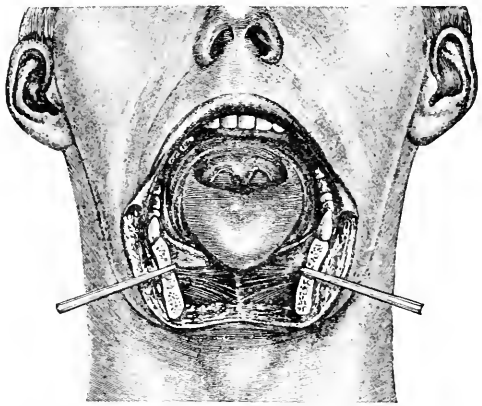


FIG. 215.—Temporary resection of the inferior maxilla. (After Sedillot.)

Partial, without complete division of the jaw.

Complete, when the jaw is completely divided.

Disarticulation, when the articular portion is removed.

Partial Resection.—Resections involving the alveolar process or part of the body of the jaw can under normal conditions be performed without an external incision. Provision must be made against the inspiration of blood, as with other mouth operations. The patient is placed in a recumbent position with the shoulders raised by a pad or sand-bag sufficiently to tip the head as far back as possible when turned as it should be toward the side away from that which is to be operated upon. The lips and angle of the mouth are held out of the way with a retractor, a gauze sponge made into a roll and clasped with a forceps placed along the inside of the jaw under the tongue. In this way the field of operation may be satisfactorily exposed and the flow of blood kept within bounds. Bone shears or bone-cutting forceps sometimes facilitate removal of the bone, or a chisel may be used. But there seems to be no reasonable doubt of the fact that

in these cases a surgical engine bur, or bone-cutting burs for the dental engine, as described (p. 76), will effect the necessary removal more rapidly with less hemorrhage, because the torsion of the vessels by the rotary motion of the bur favors their contraction and lessens the flow of blood. A properly manipulated bur leaves a smooth bone surface, which favors healing processes. If resection be made for any purpose other than malignant growths, and when the periosteum is not actually involved in disease which necessitates its removal, or in cases where it is not desirable to have pseudo-arthrosis, this membrane should be carefully preserved to as great an extent as possible, in order that bone may again be restored with a maximum of functional usefulness and minimum of deformity.

In the performance of all such operations within the mouth it should be remembered that both control of hemorrhage and proper care of the wound surface to promote healing processes may depend upon the satisfactory retention of a packing. The outline of the wound cavity should therefore be clearly defined and so formed as to facilitate both the insertion and the retention of such a packing. It is the author's practice to use plain sterile gauze in the form of a long, narrow packing strip, with all the frayed edges of the gauze so folded that there will be no likelihood of shreds becoming detached and clinging to the wound surface to give trouble after its removal. This is wrung out in 2.5 per cent. carbolic or 1 to 10,000 bichloride of mercury. Any other suitable antiseptic will do as well. When the wound cavity is almost filled a small portion of the end of the packing is saturated with collodion, packed into position, and the surface again sealed with collodion. All such packings, especially when inserted during anesthesia, should have a piece of ligature attached which can be carried out around the corner of the mouth and fixed upon the surface of the cheek with a small piece of adhesive plaster. In this way the danger that the packing may become dislodged and be swallowed during sleep is avoided, and removal is easily accomplished by drawing it out with the ligature. It is sometimes advisable to leave such a packing in the mouth forty-eight hours after the operation, but later packings should be changed daily. Once or twice a day the buccal mucous membrane surfaces of lips, cheeks, tongue and palate as well as the tooth surfaces, should be cleansed with applicators dipped in dioxogen, and instructions given to have such patients hold in their mouths 2.5 per cent. carbolic acid or other mouth wash used alternately with the dioxogen once each hour during the day.

Complete Resection.—Complete resection of the lower jaw may be performed from within the mouth, as described for partial resections, or by skin incisions along the lower border of the jaw or through the central portion of the chin and lower lip or both, or the vertical incision may extend up to but not include the lip border, according to the situation and character of the affection of jaw that is to be resected. When large segments have to be removed the external incision is by

all means more satisfactory. Not only can the operation be performed with less fear of hemorrhage, but there is a tendency in any event, when intrabuccal resection is performed, for secretions of the mouth to lodge and form a pouch in the situation of the wound. The almost invariable result of this is an opening through the external surface, which is quite likely to cause as much or more scar and deformity as a properly made skin incision. Treves[1] emphasizes Heath's suggestion that it is not wise to cut completely through one section before the other is begun; that by cutting almost through the jaw at one point, and again nearly through the other, the steadiness thus retained facilitates rapid work and prevents the irritation of the rubbing of the ends of the bone, which all who have performed this operation know to be exceedingly annoying. The excision can be completed by rapidly completing each cut (Figs. 216 and 217).

FIG. 216.—Outline of the incision for resection of the lower jaw.

When a neoplasm is the cause of the resection the structures connected with the bone must be removed, including the periosteum, but under other conditions the periosteum should be preserved with the greatest possible care. When the lower lip and bone are divided in the medial line for the removal of a section of the jaw in that region, there is danger of suffocation if the tongue is allowed to fall back and close the entrance to the larynx when the genioglossal and geniohyoid muscles are divided. In anticipation of this a ligature should be passed through the fleshy portion of the tongue so that it may be drawn upward and forward and held in that position. Most surgeons prefer the Gigli wire saw for performing the resection. The author prefers engine burs, as already stated. Whatever the instrument may be, however, it is desirable to avoid splitting or chipping the bone and to have smooth, clean-cut surfaces. Hemorrhage may be controlled by packing or ligating vessels that may be persistent.

[1] Treves: Operative Surgery, ii, 291.

Retention of the Divided Fragments.—It is important to prepare the retention appliance in advance of the operation when this can be done and its need foreseen. If there are sound teeth in the jaw at each side of the resected portion, crowns may be fitted in advance and a piece of bridge-work constructed which can be permanently cemented into place as soon as recovery has progressed sufficiently to allow its insertion. This will serve to fixate the parts with the additional support of bandages until the jaw may become secure. The author has usually found it advisable to have bridge-work for this purpose made removable. Crowns are first attached to teeth beyond the line of the proposed resection, other crowns are made to telescope over these, and the body of the bridge is made of vulcanite. The advantage of

FIG. 217.—Resection of the lower jaw.

this form of bridge splint is that it gives greater cleanliness over a necessarily uneven and changing surface than fixed bridge-work as ordinarily constructed, and that it can be altered from time to time as the jaw fills in. A modification of the Angle band splints may be employed with additional nuts so placed that by turning them force may be applied in extension to prevent drawing together of the ends of the bone by muscular action when the section has been removed, as well as to retain a proper alignment. When it is not practicable to hold the parts by either of the foregoing methods, crowns upon the upper and lower teeth with flanges outside the line of occlusion of the upper teeth are arranged that when the jaws are closed the flange will pass along the buccal side of the upper teeth

and force the lower teeth into proper alignment, thus securing adjustment. This is a modification of the plan first adopted by the Berlin dentists Sauer and Süersin. The purpose of this is to overcome the tendency of the attached section of the lower jaw to be drawn inward by cicatricial and muscular action. Dr. Martin, the well-known

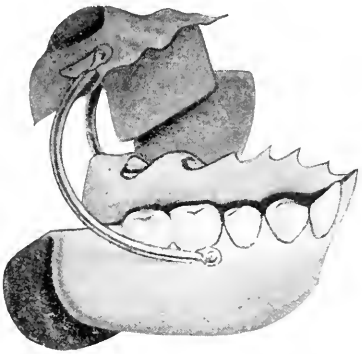


Fig. 218.—Martin's artificial denture for the support of a resected jaw.

dentist of Lyon, has originated many ingenious appliances of this character. One of these, shown in Fig. 218, is an artificial denture fitted to the lower jaw and behind to a plate which rests against the palatine surface of the upper jaw. It is adjusted so as to allow movement of the mandible, and flanges are attached to each plate in such

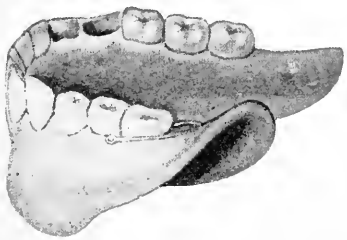


Fig. 219. — Martin's plate for a resected jaw.

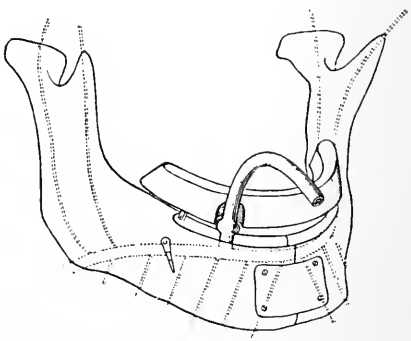


Fig. 220.—One of Martin's appliances for a resected lower jaw, with tubes for irrigation purposes attached.

position as to slide past each other and to permit the flange from the upper plate to be held upon the inside of the one attached to the lower when the mouth is closed, and thus apply the necessary retention of correct position. Figs. 219 and 220 are also Martin's devices for resected jaws.

Another of Martin's valuable suggestions, termed by him a "prothèse immediate," was published in 1889. It is the use of gutta-percha fashioned to occupy the resected segment of the jaw and firmly attached to the remaining portions. This material is easily molded into the required form and serves to hold the parts during the healing processes. Afterward a permanent appliance containing teeth and firmly attached to the bone segments by screws are made removable if necessary. It is used to supply the place of the artificial fixture (Fig. 221).

Bull reports the successful use of Martin's plan in the case of a girl, aged eighteen years, in whom it has given satisfactory services for eight or more years. A temporary splint was used immediately after the operation, and a permanent splint inserted a few weeks later which the girl was able to remove, cleanse, and reinsert without difficulty. The advantage of metal splints when adaptable is obvious.

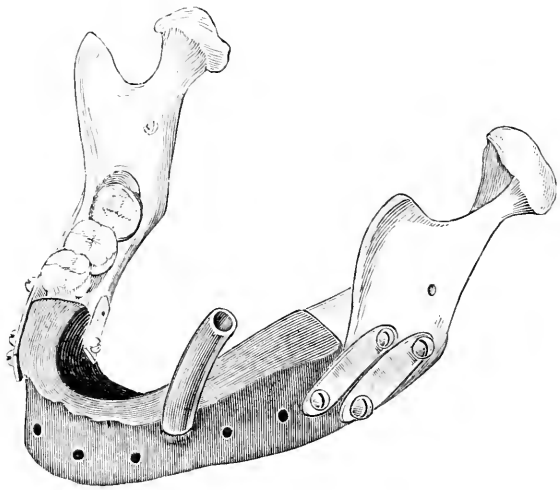


FIG. 221.—Martin's artificial jaw.

Bönnecken, Partsch, and Stoppany have undertaken to supply this need, as is shown by their artificial jaw splints illustrated in Figs. 222, 223 and 224. The purposes of their construction are sufficiently plain without detailed explanation except that Stoppany's splint, which is made of aluminum, is designed to hold the soft parts of the chin in position and to prevent the deformity which is likely to occur with other forms of support which do not have this feature.

Disarticulation.—In removal of one-half of the lower jaw the position of the patient is as previously described. A vertical incision is made through the tissues of the chin in middle line without division of the lip, and incision along the lower border of the jaw to the angle

and upward behind the posterior margin of the ascending ramus. Where the incision crosses the facial artery only the skin is divided, the artery is exposed by dissection and divided between two liga-

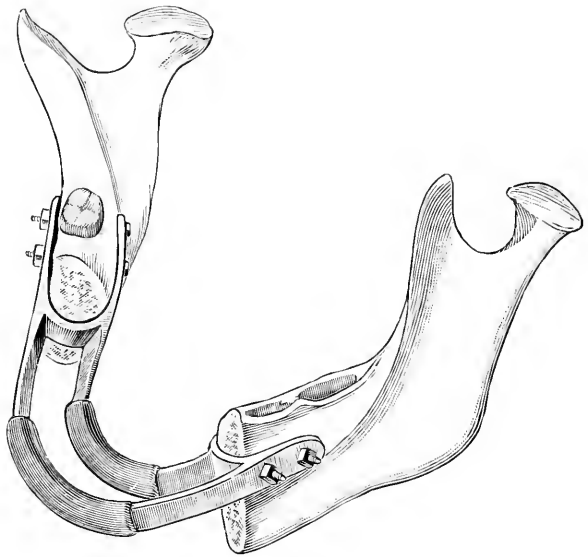


FIG. 222.—Bönnecken's artificial jaw.

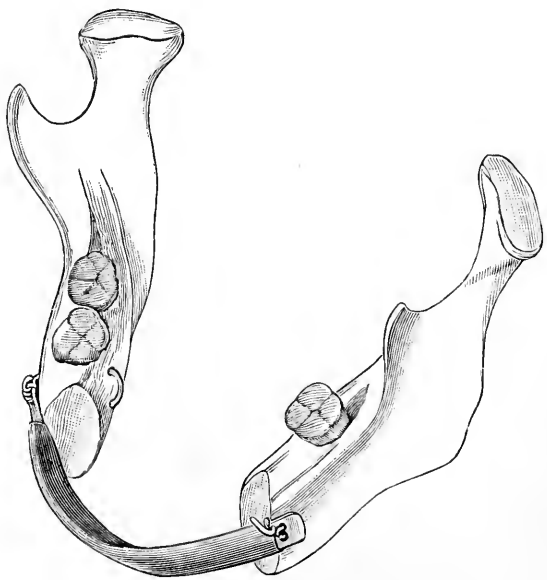


FIG. 223.—Partsch's artificial jaw.

tures. The skin and external muscles are separated together in the flap, the surface of the bone being followed closely. The mental and masseteric arteries and small vessels which are divided can be easily controlled. If there are teeth in the jaw an incisor is extracted and the jaw divided through its socket at or near the median line. The muscles are stripped from the inner side of the jaw by following the bone surface closely upon the external surface. The geniohyoid, geniohyoglossus, and digastric muscles are detached. The anterior portion of the jaw is gradually drawn downward and outward, the mylohyoid and ultimately the internal pterygoid muscles are dis-

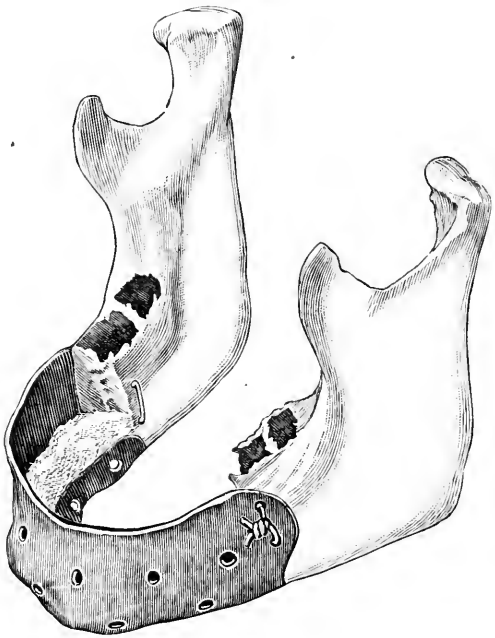


FIG. 224.—Stoppany's artificial jaw.

sected free. The inferior dental artery and nerve are exposed, the artery secured and divided. By drawing the bone outward and keeping close to its surface, injury and sublingual and submaxillary glands may be avoided. By depression of the jaw the tendon of the temporal muscle may be detached from the coronoid processes and the condyle exposed. The external pterygoid muscle is next divided, the capsule of the joint opened and the bone cut free from the internal lateral, stylomaxillary, and pterygomaxillary ligaments, and the bone removed (Fig. 225). Treves warns against laceration of the internal maxillary artery by contact with the neck of the bone if it be twisted or rotated in removal. Anyone who has opened the internal maxillary in this situation, as happened in one of the author's cases, will

not need a second warning to be careful in this respect. Tracheotomy is seldom necessary in these cases for one who is accustomed to operate in this field. *Removal of the entire lower jaw* is credited to Blandin in 1848 as the first surgeon to succeed in its performance, and is identical with disarticulation and removal of one-half, as already described, except that the vertical incision through the chin and lower lip is unnecessary. The longer time required for the operation and increased loss of blood necessarily involve greater shock with correspondingly increased danger.

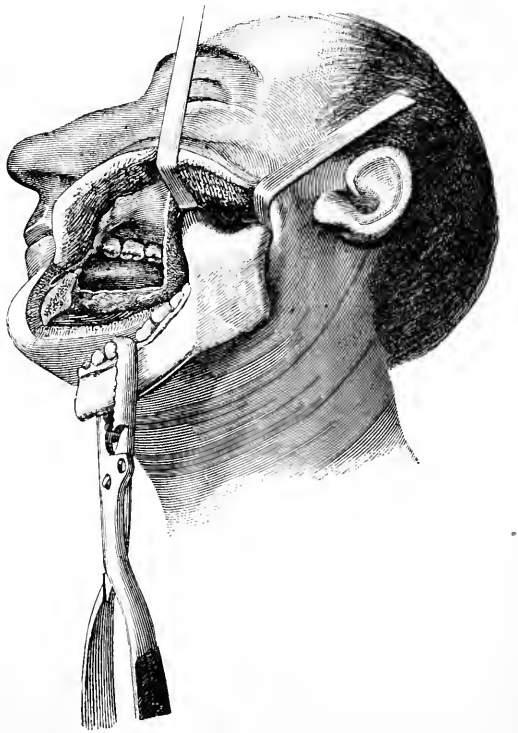


FIG. 225.—Resection of inferior maxilla. (Farabeuf.)

Prognosis and General Consideration of Results.—Entirely apart from the question of mortality, which is necessarily subject to the conditions under which the operations for resection of the lower jaw must be performed and which in most cases can be successfully controlled, the author's experience with these cases leads to the belief that prognosis is usually unfavorable and that a word of caution is demanded.

He cannot help feeling that a surgeon ought to be at least reasonably sure of permanent benefit before subjecting a patient to the postoperative disadvantages of these operations. It seems as though

prolongation of life that is to be continually made miserable is a questionable benefit, as when a detached ramus is drawn inward to irritate the tongue, interfere with speech, deglutition, and of course mastication, and have the added discomfort of dribbling saliva and deformity.

Prosthetic assistance along the lines suggested by the illustrations sometimes gives much satisfaction, but in the vast majority of such cases continued movement causes loosening of crowns or even of teeth, and removable appliances are so subject to change in the form of the jaw structures that permanent comfort is often an impossibility.

Pictures of misery such as these cases present are not soon forgotten, especially when recurrent growth of the neoplasm gives evidence of the futility of the suffering.

That through misguided judgment many lives are lost which might have been saved had more radical operations been performed before advancing malignant disease rendered surgical relief unavailing is only too true, but, on the other hand, many jaws have been resected when the affection was benign.

The author was once called upon to make necessary preoperative preparations for a splint. He saw the case for the first time as the patient was about to be taken to the operating room for complete resection of almost the entire side of the horizontal portion of the mandible, and noted that the condition was, in fact, a simple dento-alveolar abscess, not a sarcoma as previously diagnosticated. Later in the operating room he was able to prove that it was only necessary to extract a devitalized lower first molar and do a small curettement to effect a cure. This example is, of course, unusual, but it nevertheless points the way to great need of caution.

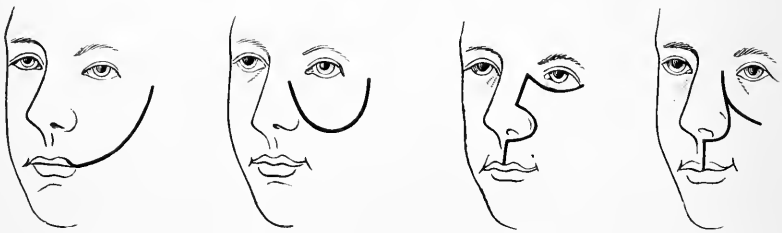
Resection of the Upper Jaw.—Definition.—This term is usually understood to mean the removal of the superior maxilla upon one side, although equally applicable when both superior maxillæ are removed. It is also used to describe partial removal of this bone. Surgically this should not be confounded with removal of the bone, even though included almost in its entirety in one or more sequestra of necrosis, because such a sequestrum does not require excision, it having already separated from the living bone except for the attachments of soft tissues. When properly performed, removal of sequestra is a comparatively simple operation with slight danger of serious damage, and can be accomplished from within the mouth without external incision. In actual resection of the superior maxilla for malignant growths, however, the surgical problems, especially with regard to hemorrhage and shock, are of very serious character, and require a high degree of surgical skill at the time of operation, as for the preoperative and postoperative steps, in order to avoid disaster.

Forms of Resection.—

Partial.	Temporary or
Complete.	Osteoplastic.

Partial resection is, as a rule, easily performed through the mouth. The position of the patient and the instrumentation are the same as described for resection of the lower jaw. Hemorrhage in these cases can, as a rule, be readily controlled by packing or the ligation of small vessels at the wound surface.

Complete Resection of the Upper Jaw.—The principal differences between the various operations for complete resection of the superior maxilla are in the lines of external incision for exposure of the parts. Figs. 226, 227, 228 and 229 are self-explanatory, and indicate the most commonly used method of gaining access to the bony field of operation. Of these, Velpeau's and Langenbeck's are objectionable because of insufficient exposure of the parts and division of the branches of the facial nerve with corresponding postoperative deformity. Weber's modification of Diffenbach's incision is generally accepted to be in all respects the most advantageous and gives complete freedom in uncovering the bone surfaces. It avoids the division of important nerves and follows lines which make the scar as little noticeable as possible.



Velpeau's. Langenbeck's. Weber's. Kocher's.

FIGS. 226, 227, 228 and 229.—Lines of incisions for resection of upper jaw.

Surgical Steps.—After the soft parts have been dissected from the bone, the bleeding vessels clamped, and capillary hemorrhage checked by dry gauze applied with pressure, or gauze wrung out of hot water, the periosteum is forced back from the floor of the orbital cavity as far as the sphenomaxillary fissure, and the eye-ball is protected with a flat instrument and gently forced out of the way. A curved needle connected with the Gigli wire saw is passed into the fissure and out at the malar fossa. With this the malar bone is divided. The articulation of the upper jaw with the nasal and frontal bones is then cut with bone shears. In division of the hard palate the Gigli saw passed through the nose, behind through the palate and out through the mouth may be used, or a long fissure bur in the dental or surgical engine may be substituted with increased rapidity and facility in many ways. The jaw is then loosened, grasped with bone forceps, and twisted out. A large gauze pad should be at hand to quickly pack the wound and check the force of hemorrhage (Figs. 230 and 231).

Osteoplastic Resections.—Osteoplastic resections of portions of the upper jaw for temporary purposes are usually performed by freeing a sufficient portion of the proposed section to admit of its being forced

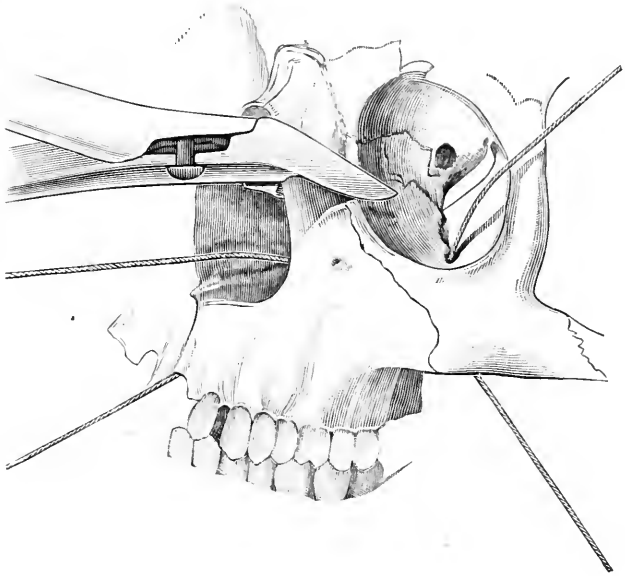


FIG 230.—Division of bone in resection of jaw. (Von Bergmann.)

FIG. 231.—Resection of superior maxilla. (Farabeuf.)

apart from the body of the bone. This is done in such a manner as to allow of its being turned back in a flap with the overlying tissues. It is then replaced without complete destruction of the surrounding periosteum. Without going into detailed description of the several operations for this purpose, such as devised by Langenbeck for exposing the base of the skull through the mouth, the various procedures for reaching the Gasserian ganglion as outlined on pages 269–272, and other less justifiable operations for removal of tumors in this way, it is sufficient to say that the external incisions for these resections are such as to permit satisfactory exposure of the division of the bone which is to be resected. Closure of the skin surfaces in all the operations upon the jaws requiring external incision should be accomplished with care to avoid so far as possible unsightly scars. Exact coaptation with fine silk or horse-hair sutures is required, or the subcuticular suture may be placed to give the perfect approximation that is desired. When there is extreme exhaustion immediately following the operation, sutures may be rapidly inserted which will hold the tissues in fairly good approximation, and after there has been recovery from shock at a later period, more perfect adjustment can be accomplished in the parts that are most noticeable.

Resections for Cosmetic Purposes to Correct Deformities of the Jaws.—Much that has been done in a surgical way in this direction has been ill-advised. The author has seen a number of cases in which resections of the lower jaw have been made to correct prognathism in which, although the surgical steps have been skilfully performed, the defective condition might better have been corrected by orthodontic procedures. The surgeons in these cases had evidently not realized that it was the upper jaw that needed widening and extension, not the lower jaw that needed reduction, and that nasal, facial and other results were associated with the contracted upper jaw which would also have been improved by treatment of the maxillæ instead of the mandible. There are, however, conditions of malformation and imperfect occlusal relation of the jaws which call for surgical interference. This may be of such nature as to bring about complete readjustment, or for the purpose of facilitating treatment in correction of orthodontic procedures.

For example when the mandible is so much longer by actual measurement from the angle on each side to the symphysis, with facial deformity such as is shown in Fig. 232, the operation illustrated in in Fig. 234 is indicated. The author's method in the treatment of such cases is to place casts of the jaws upon an articulation, cut out a section from the plaster cast corresponding to the bone to be removed. When this adjustment is perfected, a splint with bands to be cemented to the teeth, and suitably adjusted nuts and screws is prepared. This is cemented to the teeth twenty-four hours before the bone excision is

performed. When the section of the jaw has been removed the bone ends are brought together and held in perfect apposition by tightening the nuts on the appliance.

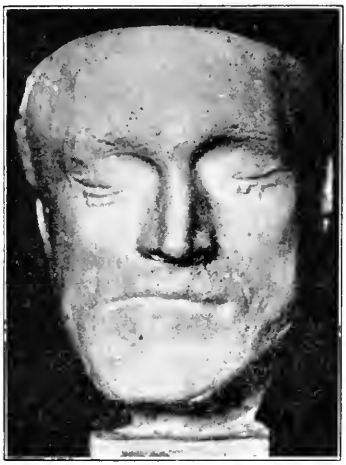


FIG. 232

FIG. 233

FIGS. 232 and 233.—Casts of the face of a young man, for whom the author removed a section from one side of the lower jaw, as shown in Fig. 234. This picture is shown through the courtesy of Dr. Joseph Eby, of Atlanta, Ga., who made the cast.

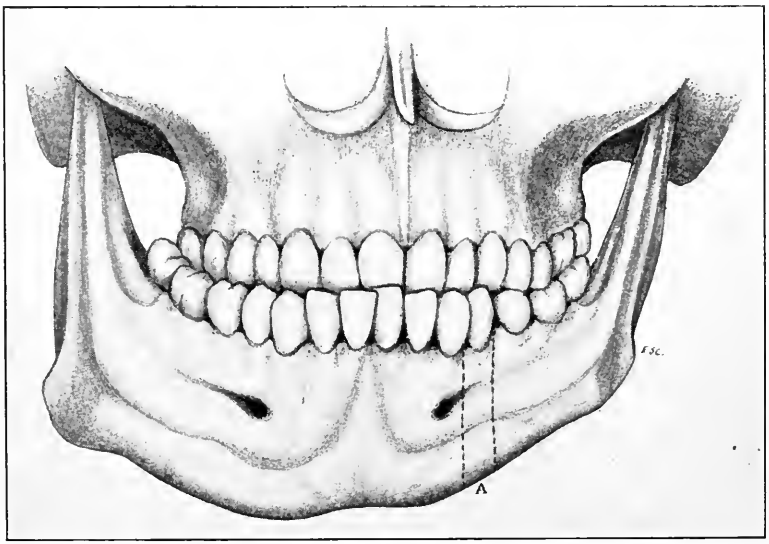


FIG. 234.—Drawing showing the deformity of the jaws of the young man, a cast of whose face is shown in Figs. 232 and 233. The dotted line indicates where the second bicuspid tooth and a section of bone completely through the jaw was removed by the use of a hand engine bur.

Let no one who values his peace of mind ever cut through a jaw without first having made provision for its retention if conditions make such preparation possible.

Section to Correct Unilateral Shortness of the Mandible.—When the deformity is exactly opposite to that illustrated in Fig. 232, as when there has been contraction due to necrosis, accidental or surgical injury, or maldevelopment from other causes, through which one side of the mandible is shorter than the other with the chin drawn to

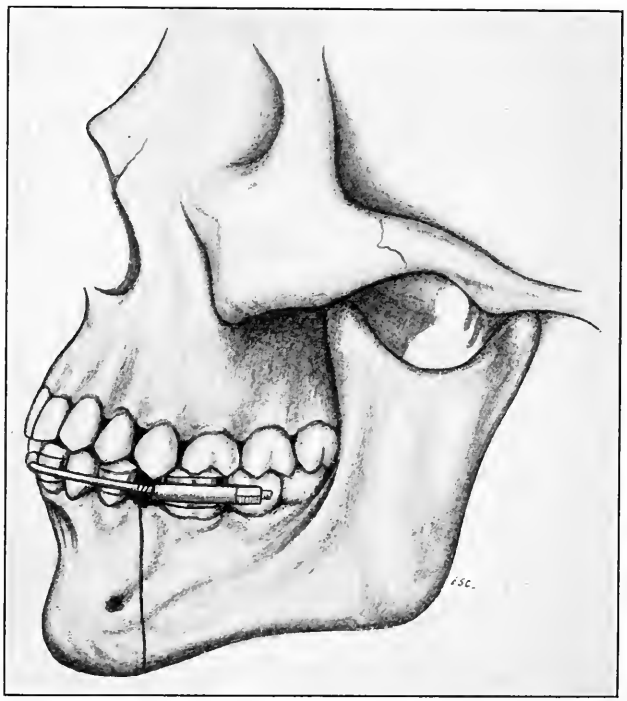


Fig. 235.—Shows drawing of the jaws as they were in the cast illustrated in Figs. 232 and 234 after removal of a second bicuspid tooth and complete resection of the jaw, the approximation of the bone ends and fixation with an appliance attached with metal bands cemented to the teeth and adjusted by a nut tightened upon a thread cut in the bar of the appliance. In most cases the metal band shown attached to the molar next to the point of excision would be better attached one tooth farther back. The situation of the bands must necessarily be determined by the condition of the case.

one side as shown in Fig. 237, a similar appliance is arranged to make extension instead of contraction after the jaw has been resected as shown in Fig. 236. Intra-oral separation is made preferably between the cuspid and first bicuspid, or between the bicuspids, with care to avoid the mental foramen and its vessels. The author uses a fine straight saw which can be passed between the teeth, and by retracting the lips can usually be made to divide the jaw-bone through the septum which separates the roots, without serious injury to the pericementum.

Beyond this the division is completed with dental engine burs, until a fracture of the undivided part of the section may be accom-

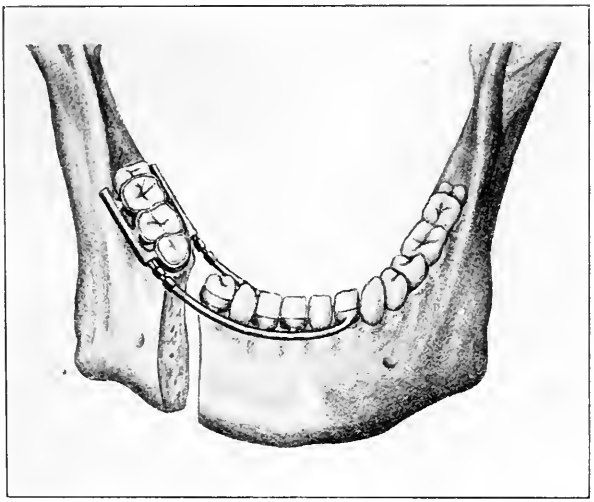


FIG. 236.—Illustration of an appliance which acts as a splint when the mandible is divided. It is also capable of exerting pressure when the nuts are turned to give extension and thereby lengthens the jaw. An increased length of one-half inch more on one side may thus be secured with comparatively little difficulty by an intrabuccal operation. If one inch or more be required then bone grafting through an external incision is required.

FIG. 237.—Photograph of a young man whose jaw was very much one-sided, with a markedly receding chin, for whom the operation illustrated in Fig. 236 was performed. Approximately one-half inch was gained on the left side of the mandible by this method with corresponding improvement in his appearance.

plished. This leaves at least a portion of the periostium intact. By turning the nuts on the appliance the pressure thus exerted may be

made to extend the mandible from one-third to one-half inch. The appliance serves as a splint to support the divided bones until bone repair has assured the permanence of the result (Fig. 237). There should be no external scar in these cases.

If conditions are unfavorable for the intra-oral operation, as when greater extension of the jaw is required, bone grafting must be resorted to. Dr. Fred H. Albee, of New York, by the use of his wonderfully accurate bone-cutting instruments removes a section of bone from the tibia and grafts it between the ends of the divided mandible. The section removed is cut in such form as to favor its retention and *mortised* into correspondingly cut receptacles in the jaw-bone.

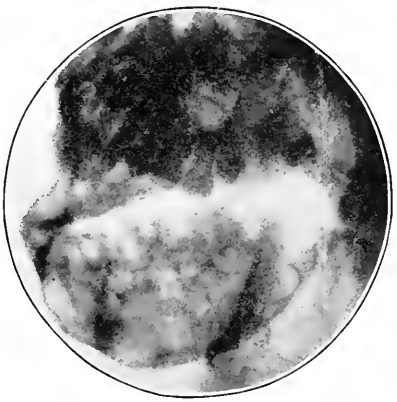


FIG. 238

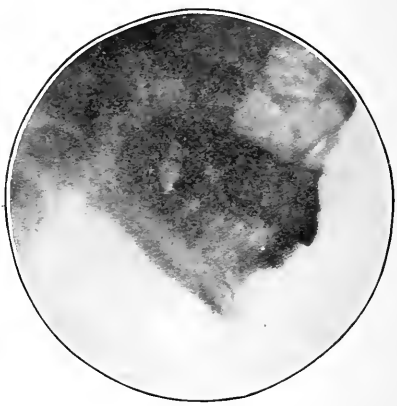


FIG. 239

FIGS. 238 and 239.—Radiographs, showing tumor and successful bone graft. The tumor was removed and a section of rib grafted into the jaw by Dr. Judd, of the Mayo Clinic.

Dr. Judd, of the Mayo Clinic, at Rochester, Minn., has reported a very successful case in which he grafted a section of rib to replace bone lost in the excision of a tumor from the lower jaw.

The external operation should be performed with care not to enter the buccal cavity. Freedom from infection is absolutely essential to successful bone grafting. The bone is handled entirely with instruments, even gloved hands are not allowed in contact with the graft. An *autograft* is by all means preferable to bone taken from another individual, and animal grafts are usually useless. The protection of the periosteal covering is also essential to the best success.

In deciding between these types of operation the author's experience in the following case may be of interest. The retention of the bone segments following an operation to restore the jaw of a young girl that was badly contracted from necrosis, was found to be exceedingly difficult and discouraging because of the absence of lower back teeth on that side. Nevertheless, by ligation of the lower to the upper teeth, sufficient retention was secured to give an improvement of approxi-

mately one-half inch. Later this patient went to the late Dr. Murphy who undertook to graft bone through an external opening. The result was loss of the graft from necrosis, a bad scar following the slow healing of a very persistent fistula through which the buccal fluids and pus discharged. The skill of this surgeon was world renowned, therefore the warning against this treatment except under favorable conditions is the more entitled to consideration.

Bilateral Resection for the Reduction of Prognathous Lower Jaws.—Blair and Angle have perfected a method of performing a submucous periosteal operation for the removal of a section upon each side of the jaw, and fixation by the aid of a splint covering the crowns, buccal and lingual surfaces of the teeth, made in three sections and cemented before the operation so that they may be fastened together immediately upon removal of the bone segments.

Blair believes that the jaw should also be wired near the lower border to give additional security. Babcock cuts through the *rami* of the jaw, slides the body back, and fastens it in this position. Harsha cuts sections from the angle on each side, and thus accomplishes the necessary shortening.

The author has seen one of Babcock's cases in which the result was perfect insofar as retraction was concerned, and Harsha's models and illustrations leave no doubt as to the success of his method in this respect; but in both of these cases it appeared that better results could probably have been attained by enlargement of the upper jaw instead of shortening the lower, and with a distinct benefit to respiration and health by such expansion.

Malocclusion with the Molars in Contact and a Wide Separation between the Anterior Teeth.—This defect which not only affects the facial appearance, but the speech also, is often very marked. Correction in young children is best accomplished by orthodontic procedures, the use of a skull cap, with chin attachment, or intermaxillary rubbers attached to appliances adjusted to the teeth to hold and regulate the pressure, will often work wonders in these cases. A large variety of appliances and methods for this purpose have been devised by many orthodontists.

In adults surgical treatment may be required. The deformity may then be corrected by the extraction of a bicuspid tooth on each side, the removal of a V-shaped section from the jaw, forcing the chin upward to make a green-stick fracture of the lower border of the jaw, and holding the parts with an appliance similar to the one shown in Fig. 235. The likelihood of shortening the jaw is an objection to the operation. Except for the external scar, the author believes that this might be accomplished more successfully by cutting through the lower border of the jaw, after making an incision through the skin, separating the intervening tissues and the periosteum, to avoid mouth infection, then forcing the anterior teeth into contact and holding them in position with interdental ligatures from jaw to jaw.

The Surgical Correction of Mandibular Deformities Due to Tumor Growths.—When the outline of the lower jaw has been deformed by tumor growth, much may be done by careful separation of the overlying periosteum, and the removal of the redundant bone structures sufficiently to restore symmetrical outlines. The periosteum is then replaced. Notwithstanding the unavoidable oral infectious influences the results in such cases are usually gratifying.

Preservation of the periosteum, and of the form of the outline of the jaw is important in these cases (Figs. 259 and 291, pp. 440 and 467).

Receding Chin.—Receding chin may be due to malposition of the mandible to attested mandibular development or to a combination of both. Jumping the bite, by orthodontic processes whereby the occlusal relation of the jaws is changed in such manner as to bring the mandible forward, is generally and successfully accomplished for children. Steadily applied pressure with appliances adjusted to the teeth may also stimulate growth. The jaw may be lengthened by bone grafting or the chin may be made more prominent by transplanting fat, or cartilage to give it an appearance of more harmonious prominence. The author does not believe in the use of paraffin injection when surgical transplantation of tissue may be made to serve the purpose.

Operative Dangers and Methods of Avoiding Them.—*Hemorrhage.*—Ligation of the external carotid is usually required, and, as a rule, is sufficient to avoid dangerous loss of blood. In more or less rare instances compression of the common carotid with temporary ligature or clamp may be required. Because of the effect upon the brain, permanent ligation of this vessel should be avoided. Dawbarn recommends reduction of the flow of blood by temporary bands made of small rubber tubing tied close to the shoulders and the thighs and drawn sufficiently to impede but not completely suppress circulation in the extremities. Crile says: "Permanent closure of the common carotid, and on account of the high percentage of cerebral softening in the cancer period of life, should be avoided. Permanent closure of the external carotid, while it is not attended by the risk, carries with it approximately 2 per cent. mortality rate from washing away of the thrombus of the ligatured stump, causing cerebral embolism."

A very large element of danger lies in the inspiration of blood or the secondary effects of inspiration, diseases of the air passages due to wound infection, bronchitis, and affections of the lungs, which are said to have been responsible for more than one-half of the deaths following this operation.

The Rose position reduces the likelihood of blood being inspired, but this position is not suitable for the performance of the operation. With the shoulders raised and the head tipped back as previously described (page 74), practically the same effect is secured as with the Rose position, with the head hanging over the end of the table but with the parts in more favorable position for operation. Crile, Warren, and others prefer the patient with head raised, and body in a semi-

recumbent position or in a sitting position. Crile uses his pneumatic suit to overcome the effect of the raised position of the body. A still safer plan is to follow the method of Bennet as modified by Crile, who passes two rubber tubes through the nose into the pharynx to a point opposite the epiglottis, and then packs the pharynx with gauze. A T-tube is attached at the nasal entrance and the vapor of the anesthetic is given through the tube. In this way there is absolute certainty of preventing blood from reaching either the lungs or the stomach.

The performance of a prophylactic tracheotomy is not required when these precautions are taken, and is objectionable for many reasons, but chiefly because the patient cannot expel mucus and secretions, the effect of which upon the pharynx and lungs is a serious menace. Martin reports 28 per cent. of deaths from this cause.

Crile has called attention to the necessity of the sparing use of anesthetics, and in grave cases favors the use of nitrous oxide and oxygen followed by ether in the smallest possible quantity consistent with avoidance of shock.

When the pharynx is not packed with gauze it must be remembered that complete abolishment of the reflexes increases the danger of blood inspiration. Sufficient insensibility to pain and unconsciousness can be maintained while the reflexes are yet sufficiently active to cause the blood to be swallowed instead of allowing it to enter the bronchi and lungs. All other considerations pertaining to preparation of the patient for grave operation as well as avoidance of unnecessary loss of time in its performance should be considered imperative.

Shock and Collapse.—In these extensive operations prevention of shock and collapse may be effectively accomplished. The important shock-producing factors are: The number and intensity of surgical contacts, as forcible retraction, vigorous and repeated sponging, blunt dissection, tearing, etc.; loss of blood; mismanaged anesthesia; and the duration of the operation. The principal factors causing collapse are: Interference with the trunk and certain branches and terminals of the vagus, excessive hemorrhage, air emboli, and anesthetic accidents.

The Removal of Both Superior Maxillæ.—The steps in removal of both superior maxillæ are identical with those already described for unilateral resection, except that division of the palate may not be required. It would seem that this operation could never be justifiable under any circumstances, yet it was performed for the first time by Heyfelder in 1841,[1] and has been done since then by a number of surgeons.

Postoperative Treatment.—The author prefers dry sterile gauze laid over the skin surface and held in position with strips of adhesive plaster. Dusting powders he has almost entirely discarded because after their immediate effect is over the powder becomes clogged about the stitches and renders their being kept clean more difficult; the dry

[1] Von Bergmann: System of Practical Surgery, i, 730.

gauze, on the other hand, absorbs moisture. If there should be infection or secretions of the mouth which work through to the skin surface at any points, they are easily and directly controlled by touching occasionally with cotton-wrapped applicators dipped in dioxogen. Gauze packing within the mouth should be as directed (page 385), and the same treatment of the mouth followed with regard to the use of antiseptic and cleansing solutions. Rectal nourishment must be continued until such time as it may be possible to give liquids satisfactorily by mouth. With care to avoid infection this may usually be done almost from the beginning, but is sometimes a matter of serious difficulty. When the wound is healed, deformity may, to a considerable extent, be

FIG. 240.—Appliance made by Dr. Jernigan in case of removal to the left upper maxilla.

overcome and usefulness of the mouth restored by an artificial denture, which in the hands of a skilful dentist can be made of vulcanite and sometimes with metal. Fig. 240 shows an appliance made by Dr. George F. Jernigan, of New York, which was successfully worn for several years. It decreased both deformity and discomfort in a considerable measure, for a man in whose case the upper maxilla on the left side had been completely removed.

Prognosis and General Consideration.—Mortality reports vary considerably, as may be seen by the following table:

Number of cases.	Years.	Mortality rate.	Reported by.
606	1827 to 1873	18.4 per cent.	Rabe.
158	1870 to 1897	21.5 "	Krönlein.
108	Recent years	30.0 "	Butlin.
230	Recent years	14.0 "	Bryant.[1]
12 (personal)	Recent years	16.0 "	F. S. Eve.
...	....	20.8 "	Krönlein.

It will be seen from the foregoing table that the results of these operations are determined by a wide range of conditions not only

[1] Joseph Bryant: Ann. Surg., May, 1908.

pertaining to the technic of the operation, but to those also under which they are performed. In this relation the character and effect of neoplasms is of vital importance. This feature is discussed in consideration of tumors (p. 431).

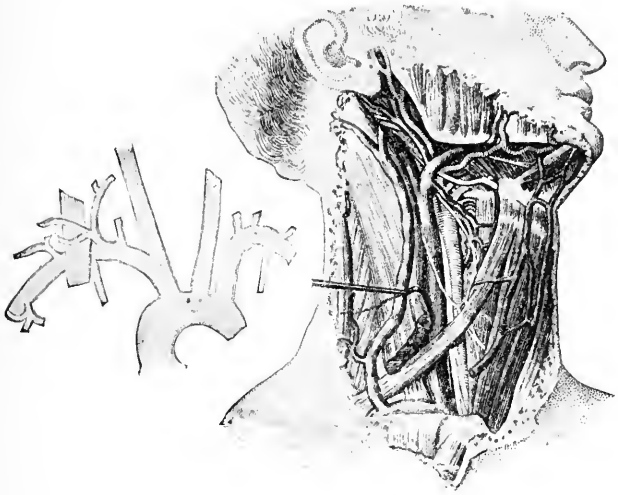


FIG. 241

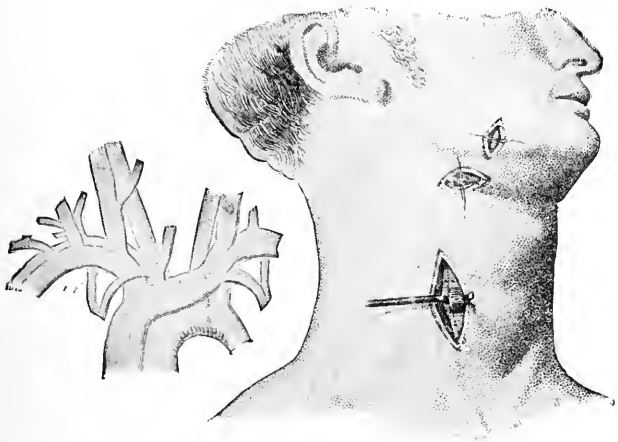


FIG. 242

FIGS. 241 and 242.—Surgical anatomy of the neck; ligation of the carotid, lingual and facial arteries. (Bernard and Huette.)

Exposure of Arteries.—In view of the fact that it may become necessary to expose the carotids, the lingual, or the facial arteries to control hemorrhage in emergency incidental to operations upon the mouth and jaws; as a preoperative safeguard in extensive operations; for

temporary occlusion by provisional ligation or the use of Crile's clamps; and excision of a section for the purpose of cutting off the circulation of certain parts to check the progress of inoperable cancers of the tongue, face, and jaws, as recommended by Dawbarn, the following brief description is given without attempt to include the ligation of the facial vessels not directly connected with the operative field.

The Common Carotid.—This vessel divides at the level of the thyroid prominence, and may be exposed by an incision of 10 cm. in length along the anterior border of the sternomastoid at its central portion, with the sternomastoid drawn outward and the other muscles inward. The artery is recognized by its pulsation. The sheath is opened and the suture passed with an aneurysm or artery needle from within outward, with care to avoid the descendens noni. The internal jugular must be carefully avoided and retracted.

The External Carotid.—Exposure of this artery may be effected by an incision from the angle of the jaw to the level of the cricoid cartilage along the anterior border of the sternomastoid. This muscle must be retracted outward. The posterior belly of the digastric and the hypoglossal nerve are avoided. The artery will be found opposite to the tip of the great cornu of the hyoid, and the superior laryngeal nerve which passes behind the vessel must also be carefully avoided.

The Internal Carotid.—This artery may be exposed at the point where it lies to the outside and back of the external carotid through the same incision by which the external carotid is exposed. The external branch is drawn inward and the digastric upward with care in passing the needle to avoid the jugular and the vagus.

The Lingual Artery.—An incision is made 2 cm. above the hyoid parallel with it from the middle line almost to the angle of the jaw. The submaxillary gland thus exposed is retracted, the fascia divided, and the posterior border of the mylohyoid exposed. The digastric tendon is then drawn upward and the hypoglossal nerve brought into view with the artery line behind it. The hyoglossus must be divided by a short incision to reach the vessel. Injury to the nerve must be avoided.

The Facial Artery.—This is easily exposed at the margin of the lower jaw in front of the angle, or it may be tied lower down through similar incision to that used for the exposure of the external carotid (Figs. 241 and 242).

CHAPTER VII.

DISEASES OF THE GLANDS.

DISEASES OF THE SALIVARY GLANDS.

The Pathological Indications of Saliva.—During recent years Michaels and Kirk have done much to bring about an understanding of the possibilities of saliva as a valuable means of diagnosis. In opposition to the theories of these writers it has been urged that the so-called saliva of the mouth is, after all, a mixed secretion of saliva, bacteria, food products, ferments, etc.; that saliva, moreover, is a secretion and not an excretion, and that therefore its indications would not be diagnostic of pathological states as are the urinary and other excretions. Nevertheless, colorimetric and qualitative examination of saliva is gradually receiving recognition as means of detecting certain expressions of disease.

More recently Roger,[1] Simon,[2] Le Roy,[3] Fenwick,[4] and other investigators have given valuable evidence that saliva has an important pathological relation to general as well as local affections.

Congenital Defects of the Salivary Glands.—Anomalous development is infrequent, but a sufficient number of cases have been reported to indicate that such anomalies must be borne in mind, as they sometimes are an important factor in diagnosis. Misplaced or absent salivary glands have been reported. Gruber found both submaxillary glands absent in one case, and in another the parotid gland appeared in the situation of the accessory parotid at the posterior border of the buccal cavity. Turner reports a case in which the submaxillary glands were found on the dorsal surface of the mylohyoid close to the sublingual glands instead of the digastric triangle. The orifices of Wharton's and Steno's ducts frequently vary. Occasionally there is atresia of these ducts or the openings may be exceedingly small or double instead of single. Cases of congenital salivary fistula have been reported by Gherini, Roser, and König.[5]

Symptoms.—The symptoms are usually indicated by alterations in the anatomical appearance. With congenital absence of an opening through the duct ranula may result, or unusual situations of the orifices may lead to exposure and irritation, thus causing pathological disturbance, displacement, or interference with nerves, bloodvessels, or other structure.

[1] Roger: Soc. de Biol., 1907.
[2] Simon: Jour. de Physiol. et de Pathol., March, 1907.
[3] Le Roy: New York Med. Jour., March 7, 1908.
[4] Fenwick: Pract. Med. Series, 1908, vol. vi, General Surgery, p. 133.
[5] Küttner: Von Bergmann's System of Practical Surgery, p. 607.

Treatment.—In the rare instances when treatment is required, the therapeutic and surgical methods necessarily are indicated by existing symptoms.

Injuries of the Salivary Glands.—The sublingual and submaxillary glands are so situated as to be more or less protected from traumatic injury. The parotids and their ducts, however, are more exposed to trauma, hence it naturally follows that these structures most frequently require treatment.

Etiology.—The injury may be surgical, or be caused by stab or gunshot wounds or accidental laceration of the glands by foreign substances forced through the floor of the mouth or external surfaces, and traumatism, particularly in the parotid region.

Prognosis.—Favorable in the absence of serious complication by infection or extensive tissue destruction.

Treatment.—Clean surgical wounds heal readily and require no special treatment other than careful suturing of the deep and superficial structures to favor immediate union and to prevent the formation of salivary fistula. In other injuries the chief difficulties lie in the forcing of infection into the substance of the gland and the destruction of tissue which makes accurate closure difficult and therefore favors the formation of fistula. If temporarily unavoidable, this can be corrected at a later operation. Fixation of the jaws for several days by a bandage which should also be so adjusted as to make firm pressure over the gland, is of aid in preventing the formation of fistula; food which unduly excites salivary secretion should be restricted to give sufficient time for healing processes to take place.

Injuries of the Ducts.—Under unusual conditions the ducts of any of the salivary glands may suffer traumatic injury. Steno's duct, extending from the parotid gland to a point close to the region of the second molar tooth in line with the lobule of the ear, and the angle of the vermilion border of the upper lip, is much more exposed than the other ducts. It lies across the region of the face most subject to injury. It is an important factor in the selection of many surgical operations requiring incision through the cheek; even with the greatest care it cannot always be avoided. Vertical wounds of the face are likely to cause its complete division. Severe blows upon the cheek have been known to cause its rupture without division of the overlying tissues.

Symptoms.—Flow of saliva from the duct into the wound may be distinguished when hemorrhage is checked. A sound passed through the orifice of the duct within the mouth appears at the point of injury.

Treatment.—The ends of the divided duct should be carefully approximated and fixed with fine catgut sutures which should not enter the lumen of the duct. Closure of the wound so as to favor exact approximation usually gives prompt and perfect union. In the absence of such care or when perfect coaptation is not possible, salivary fistula usually results. Salivary secretion must be checked by fixation

of the lower jaw and compression of the gland with a bandage as previously described.

Salivary Fistula.—Salivary fistula is an abnormal opening through which saliva reaches the surface.

Varieties.—The principal varieties are salivary *gland* fistulæ and salivary *duct* fistulæ.

External fistula, which is the only one requiring surgical treatment, is chiefly confined to the parotid gland and the duct of Steno.

Etiology.—Traumatic injury is the most frequent etiological factor, but fistulæ may also result from abscess or ulcerative processes due to pyogenic microörganisms or infectious diseases, such as tuberculosis and syphilis, or from tissue destruction by carcinoma. The origin may be within the gland or result from involvement of the glandular structure during the progress of disease from surrounding tissues. Fistulæ may also be congenital.

Symptoms.—Whether the fistula be connected with the gland or its duct, the characteristic symptom is discharge of saliva which appears through an opening upon the external surface. The saliva is annoying and usually causes more or less excoriation of the skin surface. If the flow is slight and of a watery character, a fistula of the gland is indicated because only a portion of the glandular secretion is drained. When the flow is abundant, the probability is strongly in favor of a fistula of the duct. Fistula anterior to the margin of the masseter is usually one of the duct. If the fistula is connected with Steno's duct, a sound may sometimes be passed for a considerable distance, but this is usually impossible in fistula of the gland.

Differential Diagnosis.—

DUCT.	GLAND.
Excessive flow of saliva.	Moderate amount of saliva.
Opening sometimes anterior to margin of the masseter.	Rarely so far forward as the anterior margin of the masseter.
Probe can be passed into the tract for a considerable distance.	Probe penetration only a short distance.

Treatment.—*Salivary Gland Fistula.*—This form may sometimes be closed by repeated cauterization with nitrate of silver or the galvanocautery, and such treatment is recommended as a first step. If unsuccessful, the borders of the wound should be freshened, the parts brought into immediate contact if possible, and carefully sutured. Pressure with a bandage, restriction of salivary flow by dieting, and fixation of the jaws must be continued during several days to permit union of the parts.

Salivary Duct Fistula.—*Temporary* duct fistula should be given opportunity to heal spontaneously and efforts should be made to preserve the integrity of the duct.

Permanent duct fistula may be treated by: (1) Restriction of the normal outflow of saliva through the duct. (2) The establishment

of an internal opening with closure of the external one. (3) Obliteration or removal of the gland.

Of these, the simplest and most practical is the establishment of an internal opening and closure of the external fistula. Exposure at the duct, *excision of the scar*, and closure by fine catgut sutures, as recommended by Nicoladoni, without recurrence of occlusion of the duct, are possible, and *obliteration of the gland* may be accomplished by compression, ligation of the central end of the duct, or removal of a part or all of the gland. The former method, however, appears too difficult and uncertain, and the latter, it is generally admitted, should only be attempted as a last resort. *The establishment of an internal opening and closure of the external fistula* may be accomplished by single puncture with a trocar to establish flow of saliva into the mouth. This opening must be maintained until healing processes have been completed, afterward closure of the external fistula may take place spontaneously or be accomplished by plastic operation.

In spite of efforts to preserve a single opening its closure is always a menace. A far better and simpler method, accordingly is to pass a suture behind the point of occlusion of the duct, to tie the suture loosely and allow it to remain until the two openings are permanently established. When, as frequently, the buccal portion of the duct is occluded, the suture may be passed by a curved needle in the mouth; but when the masseteric division of the duct is affected, it is better to make two openings with a trocar through the external fistula and to pass the two ends of a wire to form a loop, the ends being loosely twisted within the mouth, as shown in Fig. 243. This is better than silk or other suture material, because it does not absorb secretion and is not likely to cause infection; moreover, such a loose wire loop is moved sufficiently by muscular activity to prevent the openings from closing.

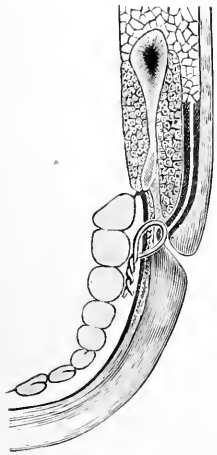


Fig. 243. — Operation for salivary duct fistula according to Deguise. (Duplay-Reclus.)

Foreign Bodies.—Etiology.—Both Wharton's and Steno's ducts are occasionally invaded by foreign bodies such as fish-bones, tooth-brush bristles, splinters of wood from toothpicks, fruit seeds, and other objects sufficiently small to enter the orifices of the ducts; projectiles may sometimes be driven into and lodged within the gland structure.

Symptoms.—There may be sharp pain at the moment of entrance, followed by swelling, more general pain continues, and other distressing symptoms are occasioned by occlusion of the duct and interference with normal salivary excretion. The distressing symptoms may disappear and recur from time to time until the foreign body is removed.

Sometimes little discomfort is felt until in the course of time the body becomes surrounded by deposits of salivary calculus, and in this way leads to the formation of salivary stone. If the foreign body is not forced out by inflammatory processes or removed, symptoms of chronic inflammation develop with discharge of pus within the gland, and as a result local and general symptoms of serious character may develop.

Diagnosis.—If the object cannot be seen or felt from the surface it may be located by passing a probe into the duct. When this is impracticable, on account of the swelling of acute inflammation, the presence of such a body can best be determined by a radiograph.

Treatment.—Remove the foreign body. If superficially situated its extraction is easily accomplished, especially if pressure can be applied to force it out of the duct. When this is impossible an incision is required for its exposure. Care must be exercised during healing of the wound to prevent occlusion of the duct. Other treatment must be directed toward relief of inflammation and abscess if such conditions be present.

Salivary Stones; Sialolithiasis.—The formation of salivary stones occurs somewhat rarely and affects the salivary glands and their ducts in approximately the following order:[1]

Wharton's duct Submaxillary gland	61.4 per cent.
Steno's duct Parotid gland	20.4 per cent.
Sublingual glands and ducts	18.2 per cent.

Concretions within the salivary glands are found most frequently in middle life and among men more often than women, although children may occasionally be affected, and a congenital case has been reported by Burdel.

Etiology.—A small particle of calculus from about the necks of teeth may find entrance into the duct of a gland and act as a foreign body or become the nucleus for the formation of a salivary stone. Other foreign substances may act in a similar manner. The presence of masses of bacteria in the interior of these concretions of lime salts, however, demonstrates that in the large majority of cases bacteria are the primary causes.

Symptoms.—Salivary stones are principally composed of phosphate and carbonate of calcium, and vary greatly in size, form, color, and number. Usually they are single and somewhat elongated, especially if situated in the ducts. Those within the glands are much more irreg-

[1] Statistics of Czygan, Buchwald and Wenzel, and Küttner. Von Bergmann's System of Practical Surgery, i, 619.

ular. They vary in size from tiny grains of sand to stones weighing 20 grams or more. The symptoms are those of foreign bodies, such as dilatation of the duct, inflammation, ulceration, and suppuration, abscesses, salivary fistula, etc. The history usually shows more or less gradually increasing disturbance, with appearance and disappearance of acute symptoms, due to salivary stasis and infection. These are sometimes very painful. Chronic discharge of pus (pyorrhea salivalis) from the duct is sometimes almost the only noticeable symptom.

Diagnosis.—If situated in the duct, the stone can usually be felt with the finger or a probe. Usually the fistulous tract is sufficiently clear to be followed into the gland also. When this cannot be done the sublingual gland may be palpated with one finger in the floor of the mouth and the other upon the outside, and the hard mass thus distinguished. When the stone cannot be felt with a probe, a radiograph must be relied upon. Ludwig's angina, phlegmonous angina, alveolar periostitis, dento-alveolar abscess, lymph nodes, inflammatory tumors, tuberculosis, syphilis, and actinomycosis must be differentiated in diagnosis. These may be recognized by their special diagnostic indications, and the demonstration of the salivary stone either with a probe or the Roentgen rays completes the diagnosis.

Treatment.—Whenever possible, salivary stones should be removed through the mouth. When situated deep within the parotid or submaxillary glands or when they have an external fistula in direct communication with its surrounding abscesses, external removal is indicated. After-treatment of the wound demands the use of antiseptic mouth washes and close observation. Timely interference is sometimes necessary to prevent occlusion of the duct and the formation of a salivary fistula.

Sialodochitis; Inflammation of the Excretory Ducts.—Etiology.—In addition to the inflammatory results of irritation and obstruction by foreign bodies and salivary stones, an inflammation of the ducts of salivary glands due to other local irritations and infection sometimes occurs.

Such inflammation rarely affects Wharton's duct, but does occasionaly create serious disturbance in connection with the duct of the parotid gland. The most common cause undoubtedly is the presence of worn sharp or jagged borders of tooth crowns, and the jaw-biting habit referred to elsewhere (p. 280). How easily such a simple etiological factor may be overlooked and how serious its consequences may be illustrated by a description of one of the author's cases.

Symptoms.—A woman of middle age, unmarried, gave a history of having had serious swelling in the region of the left parotid, which had appeared and disappeared for a number of years. Her family history gave no indications of hereditary taint. Her personal history gave nothing which might be accounted as an etiological factor except marked neurotic tendency.

Symptoms of the attacks are those of acute parotitis, the gland

became enormously swollen; she suffered greatly from pain, inability to move her lower jaw, and therefore to take nourishment comfortably, and the dread of impending developments of yet graver conditions. The attacks lasted for two or more weeks, and during this time she became very exhausted; later they gradually subsided.

Diagnosis.—Many physicians and surgeons whom she consulted during these years had been unable to recognize a definite cause for her trouble. Mumps, syphilis, actinomycosis, neoplasms, traumatic injuries, and general diseases of the glandular system were readily excluded by the symptoms and history of the case. From constant brooding over her troubles in anticipation of other attacks, her nervous state, as evidenced by trigeminal pain, a morbid view of her condition and other subjects, had become noticeable in marked degree.

Upon *examination* of her mouth it was found that abrasion of the occlusal surfaces of her molars and second bicuspids had brought them in contact in such a manner as to favor cheek biting at a point close to the opening of Steno's duct. It was easily demonstrated that during periods of pain or unusual nervousness she had been in the habit of grinding her teeth. The injury of the tissues of the cheek had caused infection, followed by inflammation and occlusion of the duct. The other symptoms were thus easily and simply accounted for.

Treatment.—One of her surgeons, Dr. C. A. Wheaton, of St. Paul, by whom she was referred to the author, had wisely refused to perform the operation for removal of the gland in the absence of positive indications of its necessity. A cure was promptly effected by rounding the buccal cusps and buccoöcclusal borders of these teeth; afterward she was referred to a dentist. The pulps of teeth which were suspected of having caused pain were removed; in two, pulp stones were found. Thus the trigeminal neuralgia, which was undoubtedly an exciting factor, was accounted for and also relieved.

Acute Primary Inflammations of the Salivary Glands (Sialoadenitis Acuta).—Etiology.—Acute primary non-specific inflammations of the salivary glands may result from traumatic injury, direct infection, and similar causes. It is generally agreed that in most cases bacteria gain entrance from the mouth and the oral cavity.

Symptoms.—The symptoms are swelling and pain, which with other signs of inflammation may vary in degree according to the nature of the cause.

Treatment.—The treatment consists of disinfection of the local wound, if any, and of the buccal cavity, hot fomentations and soothing applications for relief of the inflammations, evacuation of pus if suppuration occurs, and general treatment appropriate to all inflammatory conditions.

Mumps.—Etiology.—The exact character of the infection which causes mumps is not yet established. I. C. Erb[1] claims to have

[1] Arch. Int. Med., September, 1909, after Practical Medicine Series, Pediatrics, 1900, vii, 68.

isolated a microörganism which occurred most frequently in the form of diplococcus and occasionally in small chains. It was non-pyogenic and when injected in Steno's duct in monkeys and dogs caused a non-suppurative parotitis; occasionally it caused orchitis. This he believes to be the actual cause, but verification is required.

Symptoms.—The incubation period of approximately fourteen days is followed by stomatitis during a short prodromal stage. The first symptom usually noticed is swelling in the region of one or both parotid glands. This is most frequently unilateral and upon the left side. As the swelling increases, the skin surface becomes tightly drawn, hot, and sensitive to the touch. The edema may be comparatively slight and limited in extent, or may spread as far as the clavicle. The sublingual and submaxillary glands may be involved with corresponding alteration of the symptoms.

Fever.—The rise in temperature is usually slight, but may become serious as a result of complications which sometimes arise during the progress of the disease. In the absence of such complicating conditions the fever disappears at the end of about seven days, and this is followed by subsidence of all symptoms in the course of two or three weeks.

Pain.—Pain may be a notable feature and radiating and severe in character, or may cause slight discomfort according to the extent of the swelling and the tendency of the glands to break down and form abscesses.

Metastasis.—In adults there is often marked tendency to metastatic involvement of other glands, particularly the testes, ovaries, and other generative organs. Swellings of these organs occur with pain, tenderness, and occasional abscess formation.

Complications.—*Orchitis.*—Through metastasis there may be a very tender swelling of one or both testes, which may subside gradually under treatment or result in suppuration. The epididymis and seminal cord are generally unaffected. In treatment the parts are elevated and local applications employed to relieve the inflammation and pain.

Other complications are cystitis, nephritis, and affections of the eye and ear.

Prognosis.—In young children mumps usually runs its course with comparatively little tendency to complications. In older persons, especially when orchitis has occurred, the prognosis is much more grave. Atrophy of the testicles follows orchitis, according to Kocher, in about one-third of the cases. This may be complete or partial, and may affect both testes with resulting impotency.

Treatment.—The treatment should be in the nature of careful and regularly continued disinfection of the mouth by keeping the teeth clean, and the use of suitable antiseptic mouth washes. Local applications of heat or cold are indicated, if necessary to relieve distress. Patients should be kept warm and quiet (preferably in bed) and given nourishing, easily digested liquid diet; the bowels and kidneys should be carefully regulated.

The formation of abscesses may require treatment, or it may be necessary to relieve pain by the use of hot applications and opiates, to open and give direct relief as with other suppurative conditions.

Infantile Sialoadenitis.—This is *a form of acute primary inflammation of the sublingual and submaxillary glands without involvement of the parotid,* which sometimes affects nursing infants during the first weeks of life.

Etiology.—The etiology is not known, but, as suggested by Henning, the disease is presumably due to some puerperal condition of the mother.

Symptoms.—The glands swell rapidly and pus is discharged through the excretory ducts.

Prognosis.—The prognosis is favorable, if the general health of the infant is sufficient to withstand the effect of the sore mouth and infection.

Treatment.—The mouth should be kept clean. If suppuration is extensive, an incision is made and drainage given as in surgical treatment for the relief of other forms of abscesses.

Acute Secondary Inflammation of the Salivary Glands.—Etiology.—The causes of secondary sialoadenitis are both local and general.

Local Causes.—Local causes are the secondary results of inflammation attendant upon foreign bodies, stones, traumatic injuries, and similar factors, or infection from lymph nodes, mercurial or other forms of stomatitis, diseased roots of teeth, and the inflammatory conditions incident to malerupting third molars.

General Causes.—Such inflammations arise secondarily as complications of infectious diseases, such as scarlet fever, pneumonia, smallpox, measles, typhus fever, pyemia, septicemia, and similar affections; they also occur from carcinoma and subsequent to surgical operations through infection and general reduction of constitutional resistance, as from severe abdominal operations.

Symptoms.—The swelling usually appears in the parotid region and closely resembles that of mumps; in cases of virulent infection, however, it progresses much more rapidly and to greater extent, with corresponding alteration in the appearance of the skin, which becomes discolored and the vascular structures extensively dilated. The fever is high and there is much more likelihood of abscess formation and tissue destruction. Jaw movement is limited or completely checked. Hearing is more or less affected. In rare instances the facial nerve may be involved, but this is unusual.

If the swelling does not recede to a noticeable degree after four or five days, suppuration is indicated even though the presence of pus may not be revealed by palpation on account of the tensity of tissues surrounding the parotid gland.

Diagnosis.—Mumps usually can be excluded by history of a previous attack, and in the absence of clear testimony upon this point the fact that the inflammation of the glands is secondary makes it possible in

most cases to recognize the disease that preceded it. Occasionally the cause is hidden and differentiation from phlegmon of the neck and diseases of the jaw and lymph nodes is difficult.

Prognosis.—The prognosis is much more serious than in the case of primary sialoadenitis, but it necessarily varies with the nature of the cause.

Treatment.—*Oral Prophylaxis.*—Oral prophylaxis is a first essential. If the jaws can be opened sufficiently the necks and crowns of all teeth should be cleaned and disinfected. Mouth washes should be used, preferably dioxogen, alternately once each hour with some one of the agreeable reliable antiseptic mouth washes. When the jaws are more or less fixed, cotton wrapped upon a toothpick or probe may be passed under the lips and cheek, or between the anterior teeth, and if possible over and around the tongue.

Twice daily tincture of iodin, 10 per cent. solution, should be used in this way, and dioxogen frequently.

Efforts to Abort the Inflammation.—Hot fomentation or cold applications to the surface, bathing, and gentle massage with 30 per cent. alcohol, hot-water bags and other means of preventing the progress of the inflammation should be employed. Pain may require hypodermic injections of morphin, or iodin for its relief.

Surgical Treatment.—When an abscess is formed it must be opened and drained. The external incision is made in such a manner as to avoid important nerve structures, and blunt dissection is used to open the gland until the pus is reached. The removal of the necrotic tissue and suitable drainage is required, as in the treatment of other abscesses.

The original source of infection must receive treatment to prevent recurrence of the trouble.

General Treatment.—Aid should be given to the eliminative organs to keep up their activity, and supportive measures should be directed toward building up resistance by increase of bodily strength.

Chronic Inflammations of the Salivary Glands.—Etiology.—Long-continued and slowly progressive swelling sometimes affect these glands, particularly the submaxillary. No definite cause appears. The author's experience, however, leads him to believe that it is sometimes a result of infection from some chronic mouth affection.

Syphilis, tuberculosis, and tumors are commonly excluded as factors in these cases.

Symptoms.—The gland is more or less enlarged, slightly indurated, the overlying tissue is very slightly or not at all adherent, and the tumor more or less movable.

Treatment.—The treatment comprises correction of the cause, relief of the inflammatory symptoms, and removal of the gland if absolutely required, but not otherwise.

Chronic Secondary Inflammations.—Etiology.—Chronic enlargements of the salivary glands commonly result from the intoxications of mineral and other poisons, such as mercury, lead, copper, iodin,

opium, etc. In uremia and similar affections such glandular conditions also occur.

Symptoms.—The disease shows itself in chronic enlargements, with more or less induration of the glands.

Treatment.—Removal of the cause is usually sufficient. When chronic changes have progressed too far the glands may become a menace and require removal.

Ptyalism; Sialorrhea or Hypersecretion.—Etiology.—Inflammations of the mouth are the most common causes. It is a prominent symptom of mercurial, phosphorus, and copper poisoning; it may also be caused by certain drugs, such as the iodin preparations, jaborandi, etc. It is a symptom of certain diseases which involve the nervous system, either primarily or secondarily, such as hydrophobia, hysteria, trifacial and other forms of neuritis, and is a distressing feature of facial paralysis.

Symptoms.—The one dominant symptom is an excessive flow of saliva.

Treatment.—The cause should be corrected whenever possible. Astringent drugs are more or less recommended, but in the author's experience have usually failed to give permanent relief when the causative factor was beyond control.

Aptyalism; Xerostoma, Dry Mouth.—Etiology.—Its exact cause is not understood, but it is believed to be due to diabetes.

Symptoms.—Insufficient saliva secretion causes excessive dryness of the mouth.

Treatment.—The treatment must necessarily be empirical until its causes are better understood. The distressing dryness may be relieved by soothing local applications and correction of general conditions of health.

Bilateral Parotid Tumors.—Bilateral enlargement is more or less rare, although unilateral parotid tumor is not uncommon. The latter are commonly mixed tumors, tubercular glands, parotid cysts, or the results of infection parotid. Gordon B. New, of the Mayo Clinic, gives the following classification of bilateral parotid tumors:

1. Recurrent bilateral parotid tumors.
2. Syphilitic bilateral parotid tumors.
3. Tuberculous bilateral parotid tumors.
4. Bilateral parotid tumors associated with leukemia.
5. Mikulicz's disease.
6. Bilateral parotid tumors due probably to a local infection.

A number of cases have been reported in which bilateral swelling of the parotid glands of intermittent character was apparently due to certain kinds of food. The swelling may last an hour or two and quickly subside. Friedberg's suggestion that spasmodic closure of the ducts is brought on by the stimulation of foods, appears to be the most satisfactory way of accounting for this affection. The diagnosis of the syphilitic and tubercular types, as well as those due to local infection

and the treatment thereof must be largely determined in the same manner as for other forms of these affections. Their association with lymphatic leukemia and Mikulicz's disease, however, points to a wide field of investigation as yet too unsettled to warrant definite etiological conclusions.

Mikulicz's Disease.—Etiology.—Nothing is known of the cause and nature of this affection.

Symptoms.—The symptoms are a uniform swelling occurring usually in middle life and progressing slowly, the distinctive feature of which is the symmetrical enlargement of the glands of the head, particularly the salivary glands. Both parotids, the submaxillary, sublingual, and

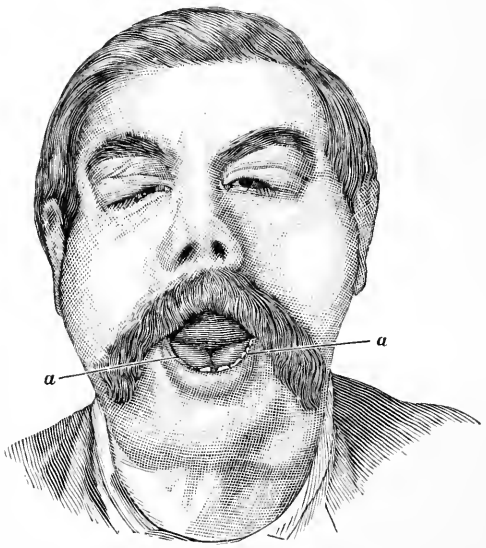


FIG. 244.—Symmetrical affection of the lacrimal and salivary glands: *a*, the enlarged sublingual glands. (After Mikulicz.)

lacrimal glands are involved, as may also be the palatine and labial glands. The parotids may become as large as a moderate-sized apple, with proportionate enlargement of the other glands. All of these glands may not be affected, but there must be a sufficient number of them to give the symmetrical effect in order that the case may be correctly diagnosticated as Mikulicz's disease. As might be expected, the adjoining lymphatics are also frequently involved (Fig. 244).

The disease does not spread beyond the gland capsule, and the tumor is therefore movable under the skin. Its consistency may vary, but there is no fluctuation and there are no inflammatory symptoms, such as pain or unusual tenderness. Osler describes one case in which there was enlargement of the spleen, and states that blood examination is negative. Movement of the jaw is interfered with, but it is not pain-

FIG. 245.—Bilateral parotid tumor associated with lymphatic leukemia. (After New.)

FIG. 246.—Mikulicz's disease. (After New.)

FIG. 247.—Mikulicz's disease. (After New.)

FIG. 248.—Mikulicz's disease. (After New.)

ful. The mucous membrane of the mouth suffers unusual dryness through imperfect function of the diseased glands. Interstitial gingivitis with marked loosening of the teeth has been described in some cases, but whether infection from this cause is an etiological factor or the condition of the teeth a result of the disease is not fully understood.

Diagnosis.—Diagnosis depends upon the symmetrical and uniform enlargement of the affected glands, the absence of inflammatory symptoms, and exclusion of malignant growths.

Prognosis.—The disease is not directly dangerous to life. Its course is variable, sometimes remaining stationary and occasionally receding after intercurrent febrile diseases or as a result of treatment. With regard to cure, the prognosis is doubtful.

Treatment.—Arsenic and potassium iodide are much recommended, and when these or similar remedies fail, surgical removal of the gland may be performed. This, however, should be avoided except in cases where such procedure is warranted by marked disfigurement.

The following diseases may primarily or secondarily affect the salivary glands as they do other structures of the body. Further description is given in detail under their respective headings as indicated.

Actinomycosis.—(See page 162.)

Tuberculosis.—(See page 94.)

Syphilis.—(See page 107.)

Ranula.—(See page 436.)

Cysts.—*Cysts of the Salivary Ducts.*—(See page 435.)

Cysts of the Salivary Glands.—(See page 435.)

Tumors of the Salivary Glands.—(See page 417.)

Adult Epithelial Tumors.—Adenomata (page 452) occasionally occur but are very rare.

Embryonic Epithelial Tumors.—(See page 444.)

Epitheliomata (page 474) are the most frequent.

Encephaloid (page 476) are rare.

Adult Connective-tissue Tumors.—*Chondromata.*—(See page 458.)

Fibromata.—(See page 460.)

Myomata (page 461) are found occasionally.

Angioma (page 462) are rare, and the diagnosis is often questionable.

Lymphangioma.—(See page 464.)

Lipoma.—(See page 457.)

Myxoma.—(See page 467.) The existence of pure myxoma of these glands is questionable, for most of them are mixed tumors.

Embryonic Connective-tissue Tumors (page 468) are rare.

Mixed Tumor (page 468) is the most frequent parotid neoplasm, and most of these are endotheliomata.

Symptoms and Treatment.—Symptoms and treatment of these growths do not differ materially in salivary glands from other situations of the body, and are therefore described under their several subjects as indicated.

DISEASES OF THE LYMPH GLANDS OR LYMPH NODES OF THE MOUTH AND ASSOCIATED PARTS.

Adenoids; Adenoid Vegetations, Pharyngeal Adenoids, Pharyngeal Tonsils, Epipharyngeal Tonsils, Postnasal Adenoids, Hypertrophy.—Definition.—Adenoids are hypertrophied lymph glands which normally exist in the epipharyngeal space. They are usually found on the superior and posterior walls of the epipharynx.

Etiology.—Practically all the factors leading to chronic irritation and inflammation in the nasal and pharyngeal regions may be grouped as causes of adenoids.

Ballenger believes their chief cause to be irritation of the epipharynx during attacks of exanthematous fever, and calls attention to the fact that lymphatic structures of children become enlarged or hypertrophied in response to bacterial stimulation more markedly than the same structures in adults under similar conditions. He holds that as the exanthematous fevers occur chiefly in early childhood there is a special susceptibility to adenoids during this period of life. It must, however, be remembered in this connection that adenoids, which may occur at any period of life but are usually found between the ages of five and sixteen years, affect large numbers of children whose histories contain no record of previous attacks of any of the exanthemata. Moreover, the common association of adenoid vegetations with other developmental abnormalities or defects and their frequent existence in members of the same family which, while the use of the term hereditary may be unwarranted, shows at least a predisposition that is undoubtedly inherited. In some cases at least there is an underlying developmental tendency, and upon this foundation any factor leading to chronic diseases of nasopharyngeal structures may act as direct causes.

Hypertrophy of the Tonsils.—In rare cases this affection is congenital, infants having been born with enlarged tonsils. Usually, however, it begins about the second year of life, and continues until young adulthood, after which there is gradual tendency to reduction in size.

While many predisposing factors are recognized and the close relation of this process to other glandular influences upon development is beginning to be understood, the essential underlying cause has not yet been definitely proved. Many disease processes may lead to tonsillar enlargement, as in acute lingual tonsillitis. The association of unhealthful nasal, buccal, and pharyngeal tissues occurs so frequently that their pathological relation appears to be beyond question.

Symptoms of Adenoids and Enlarged Tonsils.—Adenoids and enlarged tonsils are found together in the same individuals in a large majority of cases. The important features when contemplated in their relation to pathological conditions of the mouth, pertain chiefly to the general involvement of pathological and developmental conditions. This includes diseases of the mouth, nose, pharynx, throat, the sinuses of the head, the form of the dental arches, palate, and face, and their

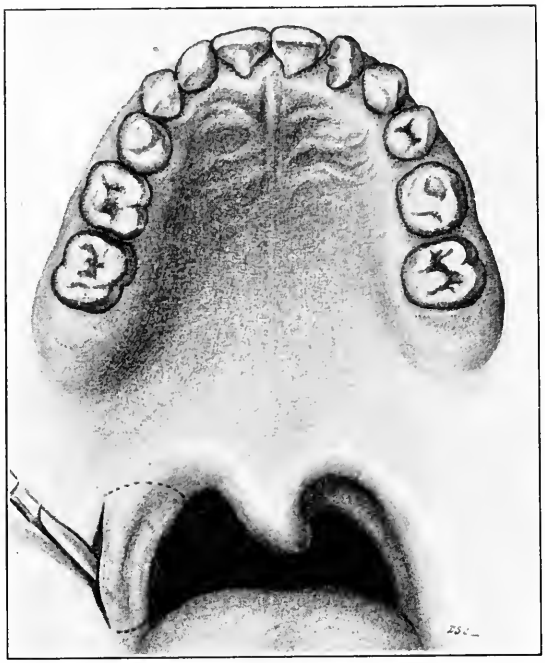


FIG. 249.—Drawing of the palate of a young woman, aged twenty years, whose faucial pillars were injured in the course of a tonsil operation, shows shortening and deflection of the palate, fluids escaped through the nose in swallowing and speech very imperfect.

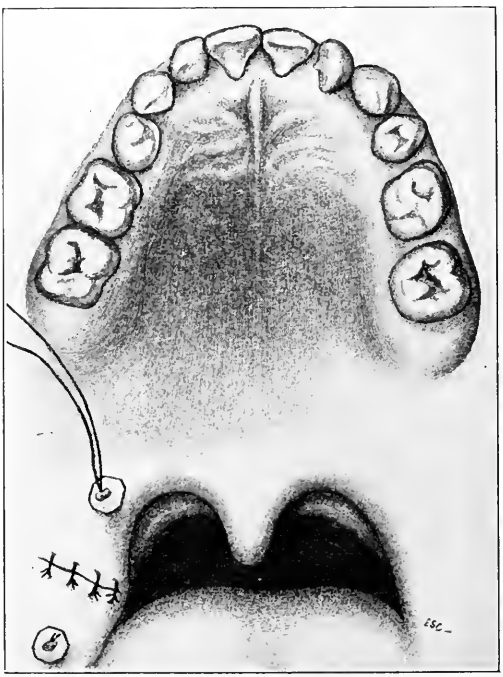


FIG. 250 —Same case after operation.

direct or indirect effect upon more remote parts or the organism as a whole. Any of these affections may be primary or secondary causes of both adenoids and hypertrophy of the tonsils as well as other diseases of the nose and throat, or the pathological influence may be exerted in a reverse direction. Knowledge of the symptomatology of

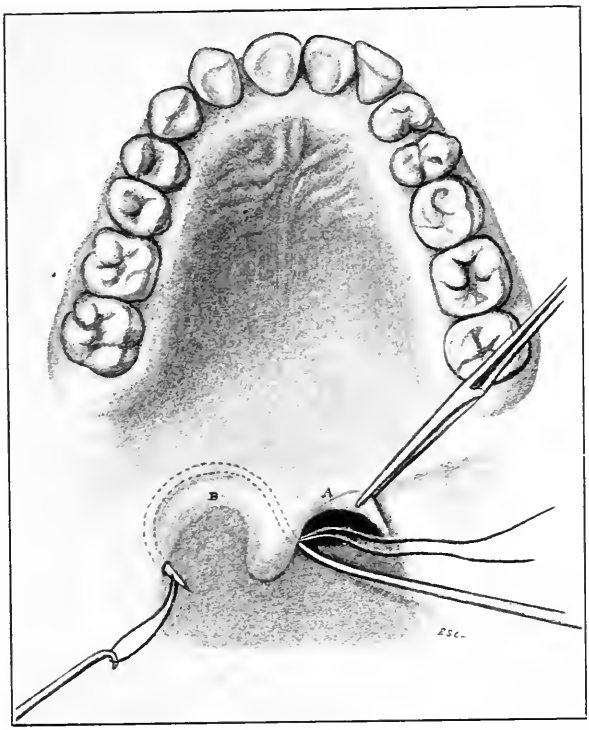


FIG. 251.—Atresia of the palatopharyngeal opening resulting from imperfect tonsil and adenoid removal. Case of a boy, aged nine years. The soft palate was adherent to the posterior wall of the pharynx on the right side, a very slight opening being left upon the left side. A number of attempts to correct the trouble resulted in failure. Among these the ill-advised, though sometimes recommended attempt to transplant mucous membrane to cover the raw posterior surface of the palate. Such efforts in these cases are useless. Mucous membrane does not transplant well, the tissues are always distorted when the incisions are made so that perfect coaptation is impossible, and there is always infection to attack the transplanted tissue. During several years of enforced mouth-breathing, nasal disease had become marked, the nares narrow and the septum deflected. As a first step the maxillæ were separated, the nares thus enlarged, the deflected septum relieved and more healthful nasal conditions secured. Following this an operation was performed as shown in the illustration, with complete relief.

these affections is therefore necessary for the oral surgeon. It is frequently a method of much importance properly to decide whether the treatment of adenoids and tonsils should precede correction of the mouth affection or this order be reversed.

Treatment.—It is the author's belief that the treatment of intranasal and pharyngeal diseases should be referred to those who specialize

in nose and throat, and that the indiscriminate attempts at removal of adenoids and enlarged tonsils by those whose special training does not fit them for the attainment of the best results in this direction is pernicious in its tendency.

For this reason no attempt will be made to describe these operations in detail in this work.

Serious and absolutely unnecessary hemorrhage, imperfect operations that caused continuance rather than relief of disease, and injuries to nerves or the tissues of the faucial pillars and the soft palate that have led such patients to apply to the author for operation for relief

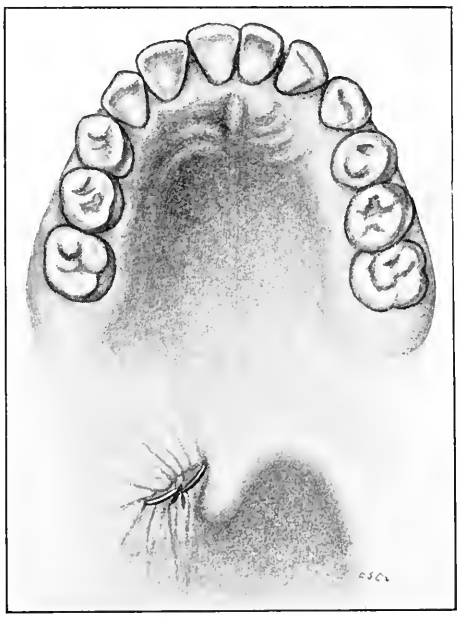


FIG. 252.—The same case as in Fig. 251, in course of correction after the ligature is tied. The usefulness of the parts in swallowing and speech was completely restored.

of speech defects, the same as cleft-palate cases, are results that have frequently come under his observation when unskilled operations have been undertaken to remove adenoids and tonsils

Examples of such postoperative defects are shown in Figs. 249–253. Fig. 249, which is a drawing illustrating the case of a young woman, aged twenty years, whose faucial pillars upon one side were injured in the course of an ill-advised tonsillectomy. She suffered great distress through imperfect speech, fluids came through her nose in deglutition, and her nervous condition became serious in many respects. Fig. 250 shows the author's operation for correction of defects of this character through which the patient was enabled to drink water, and speak without difficulty after operative treatment.

Fig. 251 presents another form of ill-result from careless or unskilful adenoid and tonsil removal in which there is adhesion of the soft palate to the posterior wall of the pharynx. This boy, nine years old, had the soft palate on one side adherent to the posterior pharyngeal wall, as a result of adenoid and tonsil operations four years previously. During this time an attempt had been made to free the palate, and transplant mucous membrane to prevent the tissues from uniting. At this operation he was under an anesthetic nearly all of one day and almost died, but the original condition remained. Attempts to stretch the parts had only made him more in terror of doctors and doctors' offices, and

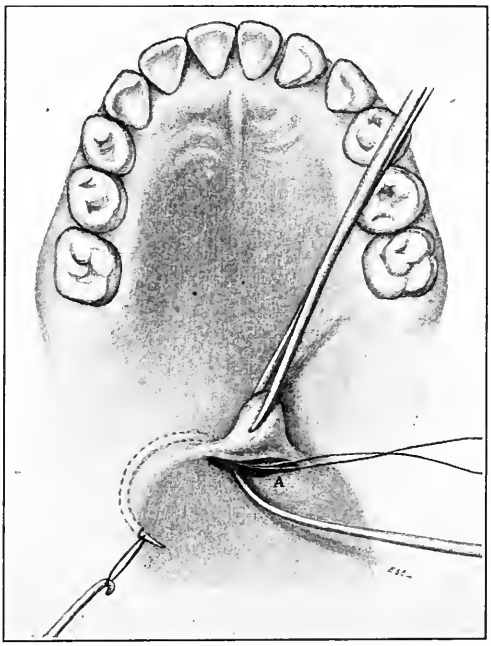


Fig. 253.—Illustration of the contracted nasopharyngeal opening of a child, aged six years, resulting from a tonsil operation. The soft palate on both sides in this case is adherent to the pharyngeal wall. The small opening just under the uvula is shown.

did no good whatever. Nasal disease, quite marked deafness, defective speech, and both palatal and nasal defects all combined to make his condition very serious. As a first step, his maxillæ were separated to enlarge the nares and facilitate more healthful pharyngeal conditions. This gave marked improvement in respiration, better general health, and a more healthful condition of the local tissues and secretions, after which the operation illustrated in Fig. 252 was performed with complete success.

In these cases cutting the palate free from the pharyngeal wall only results in their reuniting again with additional scar contraction.

The loop suture causes pressure, absorption, and the tendency is toward progressive increase of the nasopharyngeal opening, instead of its becoming smaller as would otherwise occur. Fig. 253 indicates the condition of almost complete stenosis of the nasal pharyngeal passage of a child, aged six years. This little fellow is a twin, ever so much smaller, bent-shouldered, more markedly nervous, and generally ill developed than his brother. The difference is undoubtedly due to the atresia of the palate and its consequences, all of which were caused by the removal of adenoids and tonsils in an unskilful manner. Fig. 253 shows the operation which was performed by which benefit was given to enable him to improve in both health and speech.

Suprahyoid Median Phlegmon.—**Etiology.**—This affection is obviously due to some form of infection and is undoubtedly closely allied to Ludwig's angina.

Symptoms.—In typical cases the patient keeps the mouth open, salivation and deglutition are impossible, respiration is interfered with. A swelling will be found in the suprahyoid region in the mouth, an elevation of the floor which lifts up the edematous tongue. In some cases the condition can only be discovered by bimanual palpation, one finger in the mouth, the other under the chin.

Treatment.—Prompt treatment is required. An incision should be made from the tip of the chin nearly to the hyoid. Incision in the mouth is advisable only when the collection protrudes more into that cavity. There is no occasion to wait for formation of pus, the appearance of the swelling together with its rapid extension both attest the gravity of the condition. Lejars[1] cites a case showing the dangers of delay: "A man, aged sixty-five years, apparently in vigorous health, had a swelling such as had been described; as the fever was slight and the general condition good, some days passed with nothing done but lavage, etc., then a short intrabuccal incision evacuated a little blood. However, there was some relief, and again for some days nothing more was done, the swelling grew larger and the whole region was thick and swollen. The actual cautery was used and some pus and turbid serum evacuated. There was improvement for forty-eight hours, then the swelling rapidly extended laterally; this time heroic measures were undertaken, the region was freely opened and punctured with the cautery, but it was too late."

Lymphadenitis; Lymphangitis.—These terms denote inflammation of the lymph node.

Etiology.—Practically every form of infection affects the lymph nodes because of their unusual susceptibility to the influence of bacteria or their toxic products. Tuberculosis, syphilis, bubonic plague, leprosy, actinomycosis, glanders, diphtheria, scarlet, typhoid, and other fevers, and infectious diseases give rise to adenitis, which may be apparent in the lymph channels of the neck or other regions. Infection from

[1] Semaine méd., November 10, 1909.

disease of the mouth is, of course, an important factor in this relation. This is emphasized by Coplin[1] as follows:

"Cervical tuberculous lymphadenitis is clearly the result of infection from the oral and pharyngeal cavities. Halle found that in 3161 children with enlarged cervical glands, 2334 had carious teeth; and of these, 1646 corresponded in location with the enlarged glands. Edenthal, among 987 children, found decayed teeth in 429; 424 of these had enlarged lymph nodes. Halle demonstrated that if cavities in the teeth of dogs be packed with Prussian blue and cemented, the pigment may, in from two to three days, be present in the nearest lymph nodes. Dieulafoy and others have shown that tonsils—frequently without evidence of tuberculosis—may contain the bacillus, and that the organism often is present in adenoids."

Symptoms.—Inflammation of a lymph node may be acute or chronic. In acute cases the node becomes swollen, tense, and tender. On account of the obstruction to the passage of fluid the swelling may extend to other tissues of the area drained, thus giving rise to a *paralymphadenitis*. The course may be fulminating and pass more or less rapidly to suppuration until the gland becomes a necrotic mass (bubo), or chronic changes may take place with induration that may persist for months or years without noticeable change.

Treatment.—The treatment must, of course, be governed by the nature of the cause. If due to mouth infection, the buccal secretions must be disinfected and the local disease properly treated. Tuberculosis, syphilis, and general infections require measures appropriate to the general treatment of such diseases.

In the absence of entirely evident sources of infection in the mouth, such as extensive dental caries, discharging dental abscesses, extensive diseases of the mucous membrane, and similar affections, care should be taken to test the responsiveness of all the teeth upon the affected side to heat and cold in order to determine whether by any chance there may be a devitalized tooth. Without giving outward evidence of disease or noticeable symptoms of pain, such teeth have been frequently known to be the source of extensive infection which is the more to be feared because the real cause is apt to be overlooked.

Another valuable method of examination for the same purpose is to test the color of teeth by the use of a small electric mouth lamp. This usually reveals difference in translucency between devitalized teeth and those having living pulps. If a tooth be found in a devitalized condition, its history must be carefully studied to learn whether the pulp has been previously extracted and the roots properly filled or not.

Many times the only satisfactory method is to have a dentist open the root canals and thoroughly cleanse and fill them as a matter of precaution.

[1] Manual of Pathology, pp. 445 and 446.

Interstitial gingivitis, especially in the form of pyorrhea alveolaris, with chronic discharge of pus from pockets about the necks of the teeth, is a relatively frequent cause, and in many cases easily overlooked in superficial examination of the mouth. Discharges from beneath gum surfaces surrounding the crowns and necks of partially erupted teeth are also a cause that might readily be overlooked. Adenoids and enlarged tonsils are sources of infection constantly under the observation of dentists as well as other practitioners.

When a chain of lymph nodes is involved, and it is evident that the infection has extensively invaded the cervical lymphatics, the removal of such glands by complete dissection is called for (see page 487). The modern tendency, however, is to treat these nodes individually if there is no evidence of extensive invasion and when operation can be performed sufficiently early to enucleate and remove the particular node that is affected without extirpation of the entire chain *en masse*. The *x*-rays appear to exert a valuable influence in the treatment of these cases.

"Hodgkin's Disease, Lymphadema, Lymphadenoma, Lymphosarcoma, Progressive Lymphadenoid Hyperplasia, Malignant Lymphoma, Simple Adenia, Pseudoleukemia, Malignant Lymphadenoma.—These and other more or less synonymous terms have been applied to a peculiar form of lymphoid change in which one or more of the lymphadenoid tissues of the body are involved, including not only the lymph nodes, the spleen, and the tonsils, but even the lymphoid tissues of the various mucosa. Without doubt a number of conditions have been included in this group. Careful study by modern methods, particularly the investigations by Reed, Simmons, and Longcope, render it possible to recognize a fairly definite anatomical picture, which is distinct from neoplasms affecting the lymph nodes and not due to any form of infection with which we are at present familiar."[1]

Etiology.—Dr. John L. Yates, of Milwaukee, with Dr. C. H. Bunting,[2] of Madison, isolated and definitely identified an organism which, in February, 1912, they named B. hodgkini. Bunting has been able to cultivate it from all fresh affected tissue, wherein the histological diagnosis was positive, or where the blood picture of the patient was characteristic unless that tissue had been contaminated, or had recently been actively treated by the *x*-rays. Yates[3] defines a group of the closely related affections of which Hodgkin's disease may be taken as a most characteristic example as

"A non-communicable infectious granulomatous process due to B. hodgkini (or to similar, but as yet undifferentiated microörganisms), protein in the resultant local (tissue) and general reactions, and therefore in clinical manifestations. He differentiates these groups in the following manner:

[1] Coplin: Manual of Pathology, p. 448.
[2] J. L. Yates and C. H. Bunting: John Hopkins Hosp. Bull., vol. xxvi, No. 297.
[3] J. L. Yates: Johns Hopkins Hosp. Bull., November, 1915, vol. xxv, No. 280. Colorado Medicine, February, 1916.

Group 1. Type, *Hodgkin's disease.*
Group 2. Type, *lymphosarcoma.*
Group 3. Type, lymphatic leukemia, pseudoleukemia, chloroma.
Group 4. Type, chloroma, Banti's disease.
Group 5. Type, chronic hypertrophic arthritis.
Group 6. Type, elephantiasis-like cellulitis.
Group 7. Type, mycosis fungoides.

The common factors in these diseases, as we have observed them, are in brief as follows:

1. The presence (or history) of a primary focal inflammatory lesion, usually, but not necessarily, in the upper part of the digestive or of the respiratory tract (teeth, tonsils, adenoid tissue, sinuses, bronchi).

2. Progressive enlargement of the lymph nodes, with or without accessory extranodal tumors.

3. Chronic course, with late moderate secondary anemia and with the constant development of a fever, usually of an irregularly intermittent character, exceptionally of the Murchison type.

4. Eventual fatal termination within a relatively brief period of years (two to five).

5. The occurrence during the course of the disease of either the blood picture described by Bunting as the primary blood picture of Hodgkin's disease, or of a leukemic blood picture.

6. The occurrence of a primary lesion in the germinal centers leading to an early loss of architecture in the lymph nodes through an extensive proliferation of diverse cells but with common factors in the picture.

7. The constant occurrence in the lesions (nodal and extranodal) of organisms of the diphtheroid type.

Symptoms.—Usually the enlargement of cervical lymph nodes first appears, and clusters of these become prominent in a short time. They may be in more or less isolated masses or completely surround the neck. The axillary and inguinal glands next follow. Internal nodes may also be involved. The spleen, thymus and thyroid bodies, liver, pancreas and suprarenal capsule may become involved. In rare cases lymphoid growths occur in the central nervous system (Figs. 254 and 255).

Treatment.—First, elimination of the portal or portals of entry of the infection (inflamed tonsils, teeth, accessory sinuses, dermatitis, bronchitis, enterocolitis, etc.); second, wide extirpation of all eradicable involved tissue; third, improved general health through hygienic measures, present by radiation, immune serum, and medication any extension of the disease, and to repeat these treatments at intervals of a few months.

Prognosis.—Yates[1] believes that by early diagnosis, and prompt radical treatment at least some cases can be cured, and the disease need not necessarily terminate fatally.

[1] J. L. Yates and C. H. Bunting: Jour. Am. Med. Assn., March 10, 1917, pp. 747–751.

Tumors of the Lymph Nodes.—Lymphangiomas; Localized Lymphatic Dilatation.—These comprise macroglossia or lymphatic enlargements of the tongue and macrocheilia.

Varieties.—*Lymphatic nevi*, small areas of colorless dilated lymphatics, *cavernous lymphangiomas*, irregular compressible tumors made up of masses of dilated lymph vessel or a coalescence of several dilated vessels, and *cystic hydroma*, commonly called hydrocele of the neck.

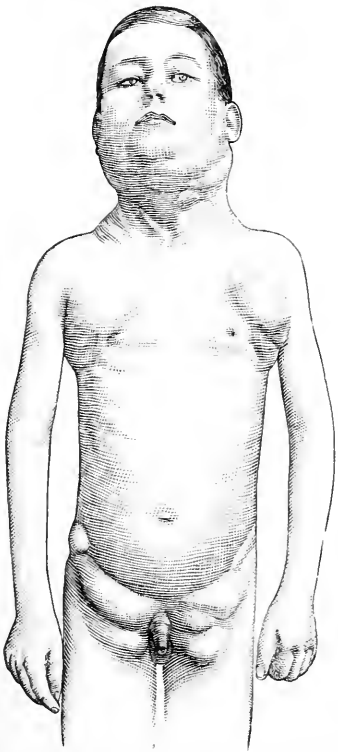


FIG. 254.—Hodgkin's disease. (After Brewer.)

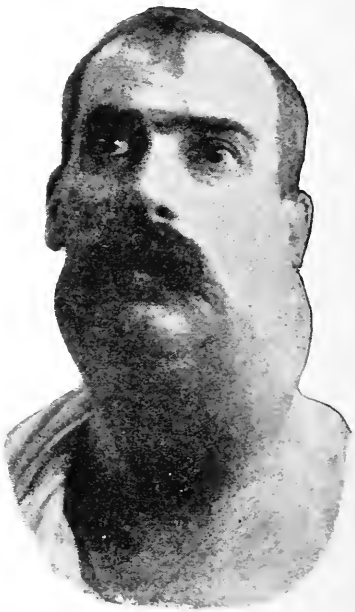


FIG. 255.—Hodgkin's disease.

Etiology.—The etiology is obscure. The Filaria sanguinis hominis is credited with being the cause of certain forms of these affections. Other forms, such as *macroglossia*, lymphatic enlargement of the tongue (page 542), and *macrocheilia*, lymphatic enlargement of the lips, are congenital affections due to lymphatic obstruction.

For further description and treatment see page 573.

Other Tumors.—Osteomata, chondromata, and endothelioma occasionally but rarely involve lymph nodes. Both sarcoma and carcinoma may affect the lymph nodes as primary or secondary affections. (The important position of the lymph nodes of the neck in relation to malignant growths of the mouth is fully described in consideration of these affections on pages 482, 487 and 489.)

CHAPTER VIII.

TUMORS.

According to strict definition a tumor is a swelling. Etymology warrants the use of the word tumor in this sense, and in the past it has been somewhat generally applied to designate any abnormal swelling, including those of inflammatory character now termed infectious granulomas as well as other circumscribed newgrowths of tissue. At present its meaning is restricted so that the term tumor is only used to denote *neoplasms* and *cysts*.

NEOPLASM.

"Neoplasm is a morbid growth characterized by a tendency to persist or increase in size independently of changes in the metabolism of contiguous or systematic structures and performing no useful function."[1]

"Circumscribed enlargement of a part due to the presence of morbid growth."[2]

Etiology.—The vague attribution of tumors to humors of the body and of the blood in the past as well as many more recent explanations, are being rapidly displaced in the light of newer research. Experimentation by inoculation of mice and other animals and closer study of tumors in human beings is rapidly leading to a time when the etiology of malignant growths may be definitely determined. At present, however, there is no known cause or generally accepted theory with regard to their origin.

Virchow's demonstration of his law, that "The cellular element of the tumor are derived from preëxisting cells of the organism," and *Müller's Law,* that "The tissue that forms the tumor has its type in the tissues of the organism either adult or embyronic," are generally recognized as fundamental. With these in view it may be stated that the following are the only theories worthy of consideration:

Heredity.—The many cases that have, from time to time, been reported in which blood relations have been affected by neoplasms of similar character lends color to the belief that there may be an inherited tissue predisposition to malignant growths. Beyond this there is no evidence to prove direct heredity.

Parasitic Influence.—According to the germ theories that have been advanced, the formation of malignant neoplasms may be due to an

[1] Coplin: Manual of Pathology, p. 308.

[2] Dunglison's Medical Dictionary.

animal parasite belonging to the protoza or a vegetable organism belonging to the blastomycetes. Although neither of these explanations of tumor causation are fully accepted, the trend of modern clinical pathological and experimental research appears to point in this direction. In support of the belief that parasites of some kind are responsible for neoplasms the following characteristic features of such growths may be noted.

Local Infectivity.—Local infectivity or extension of cancer from one part to another when there is contact of the surfaces is frequently observed. By instruments and otherwise the disease has also been extended. *Metastasis* is generally recognized as equivalent to an inoculation.

Inoculation Experiments.—The "Jensen mouse tumor" has been transplanted thousands of times. Immunity between species, and natural, as well as acquired immunity which have been demonstrated in the course of experimentation are not unlike the same conditions in infectious granulomas.

Microscopic Findings.—Gaylord and others have shown the actual presence of parasites in cancerous growths, but microscopic findings which have been reported favorable to the recognition of a definite cancer parasite are not generally accepted. Secondary invasions of bacteria into tumor growths frequently occur and confuse the findings in this respect.

Embryonal Theory.—The embryonal or Cohnheim's theory presupposes an anomalous embryonic development leading to the inclusion or misplacement of portions of the original blastodermic layer in the midst of tissues derived from a different layer of the embryo—the so-called *embryonic rests.*

Certain forms of tumor, notably ovarian, parotid, and dermoid, seem to bear out the truth of this theoretical explanation, but others do not, and it does not explain the proliferation of the embryonal rests.

Irritation and Trauma.—Whatever the true cause may be, the fact remains that, clinically, tumors are found to appear so frequently in the sites of previous traumatic injuries and tissues subjected to long-continued irritation or chronic inflammation that every surgeon must be convinced of the important relation of such factors.

Classification.—In the absence of full knowledge of the etiology of tumors the various classifications that have from time to time been presented by authors, founded, as they have been, upon not fully justified theories of origin, character, and development, are unwarranted in the opinion of the more recent writers on pathology, notably Coplin and Stengel. Based upon Müller's law, "The tissue that forms the tumor has its type in the tissues of the organism, either adult or embryonic." Coplin suggests the tentative classification, according to the resemblance of tumors to normal tissues shown on p. 434.

Pathology.—Most tumors live at the expense of the organism and add nothing to its development or nutrition. A few possible exceptions

are noted in attempts at milk formation in cancer of the breast, biliary pigment formed in carcinoma of the liver and glycogen found occasionally in large quantities in some tumors. These are assumed to be functional attempts. The disturbance of general health is explained as being possibly due to interference with organic function, secondary inflammatory changes, and the absorption of noxious products, but all of these features will be to some extent matters of conjecture until the true etiology of tumors is understood.

Primary tumors are original growths. *Secondary tumors are metastatic extensions.*

Tumor enlargement or extension takes place by (*a*) *Interstitial*, by proliferation of its cells uniformly within the tumor. (*b*) *Dissemination*, which may be (1) growth by infiltration or extension of the tumor in surrounding tissue, usually the lymph spaces and without a sharply defined border; (2) by metastasis.

Metastasis.—The transplantation of a tumor from one part of the body to another may take place through lymphatic or venous channels and extend for considerable distance along the lines of their distribution. Tumor cells may be carried as emboli along the lymphatic or venous channels, to result in a secondary growth in some new location, or a tumor may spread over membranous surfaces such as the peritoneum, pleura, and occasionally mucous membrane surfaces to form new foci at various points.

Benign tumors have been known to recur after removal, as in cases of nasal polypi and keloids of the skin, or to cause primary tumors or metastasis as in adenomas, chondromas, and leiomyomas.

Pigmentation results from hemorrhage within the tumor and disintegration of the blood-coloring matter, or may be due to pigment-producing cells, as in a chloroma, melanotic sarcoma, etc. It is also claimed to be due to certain bacteria when tumors are ulcerated.

Diagnosis.—In a general way the clinical distinctions between benign and malignant growths are as follows:

MALIGNANT.	BENIGN.
Rapidity of growth.	Grows slowly.
Invasion by infiltration, with tendency to break down surrounding tissues.	Does not extend by infiltration or invasion of surrounding structures. (Most benign tumors are circumscribed but a few, such as lipomata, may be diffuse.)
Recurrence after removal.	Does not usually recur when completely removed.
Formation of metastases.	Practically no tendency to metastasis.
Tendency to produce cachexia.	Does not cause cachectic conditions.

General Form for Diagnostic Description of Tumors.—Situation, formation, size, number, consistence, color, mobility, sensibility, influence, if any, upon surrounding structures; history of growth; history of patient (age, sex, social condition, occupation, habits, heredity, general nutrition), and previous history of the organ or tissue involved.

TUMORS (THOSE IN ITALICS ARE MALIGNANT).

- Tumors
  - Neoplasms
    - Epithelial (epiblast and hypoblast)
      - Adult (typical benign)
        - Papilloma
          - Skin warts.
          - Villous warts.
        - Adenoma
          - Intracystic warts.
          - Acinous.
        - Neuroma[1]
          - Tubular.
          - Ganglionic neuroma.
        - Glioma
          - Myelinic neuroma.
          - Amyelinic neuroma.
      - *Embryonic (atypical, malignant)*
        - *Carcinoma or Cancer*
          - Epithelioma
            - *Squamous.*
            - *Tubulated.*
            - *Cylindric.*
          - *Glandular*
            - *Scirrhus.*
            - *Encephaloid*
            - *(Colloid, Mucoid, Melanotic).*
    - Connective tissue (mesoblast)
      - Adult (typical or benign)
        - Lipoma
          - Simple.
          - Fibrous.
        - Chondroma
        - Osteoma
          - Eburnated.
          - Compact.
          - Spongy.
        - Fibroma
          - Simple
            - Hard.
            - Soft.
          - Fibroma molluscum.
          - Keloid.
        - Myoma
          - Leiomyoma (unstriped).
          - Rhabdomyoma (striped)
        - Angioma
          - Hemangioma (blood-vessels)
            - Simple.
            - Cavernous.
            - Plexiform.
          - Lymphangioma (lymph vessels).
        - Myxoma
      - *Embryonic (atypical malignant)*
        - *Lymphoma (?)*
          - *Round-cell*
            - *Large.*
            - *Small.*
          - *Spindle-cell*
            - *Large.*
            - *Small.*
        - *Sarcoma*
          - *Myeloid.*
          - *Mixed-cell.*
          - *Alveolar.*
          - *Melanotic, cystic, etc.*
    - Mixed——Teratoma (both epithelial and connective tissue).
  - Cysts
    - (1) Retention (occluded excretory ducts).
    - (2) Exudation (accumulations in closed cavities).
    - (3) Cystomas (new formation).
    - (4) Extravasation (those forming from extravasations).
    - (5) Dermoid (congenital and due to inversion of the cutis and to imperfectly closed fetal clefts).
    - (6) Parasitic (due to animal parasites).
    - (7) Cysts resulting from necrotic and degenerative changes.

CYSTOMAS.

A cyst consists of a connective-tissue membrane or supporting wall lined by epithelium or endothelium and forming a cavity, the

[1] Coplin: Manual of Pathology, p. 366.

contents of which may be fluid or semifluid, uniform in composition or made up of a mixture of similar or dissimilar substances. Cysts are described as *simple* or *unilocular* when single, and *multiple* cysts when there are several cysts together, which are identical in cause and structure.

Proliferous cysts are those in which the cyst walls continue to spring from each other or proliferate.

Multilocular is the term applied to those in which a number of cysts together remain distinct, *carernous*, to those that communicate.

Papilliferous cysts are lined with papillomatous masses.

Classification.—(1) *Retention cysts*, due to the occlusion of excretory ducts of glands. (2) *Exudation cysts*, caused by accumulations in cavities not supplied by excretory ducts, as bursæ, tendon sheaths, etc. (3) *Cystoma*, a cyst that is the result of a new formation. (4) *Extravasation cysts*, those formed around distended or ruptured vessels. (5) *Dermoid cysts*, congenital cystic results of cutaneous inclusion, or inclusion of a blighted ovum. (6) *Parasitic cysts*, caused by animal organisms, as trichinæ and other parasites. (7) *Cysts resulting from necrotic and degenerative changes in solid tissues*, such as those formed in neoplasms from hemorrhage liquefaction, necrosis, and other forms of softening, as well as other degeneration processes.

Retention Cysts.—Cysts of the Mucous Glands.—*Etiology.*—Occlusion of the ducts of these glands from inflammatory or other causes leads to cystic formation.

Symptoms.—The cysts appear on the inner side of the lips and cheeks and on the under surface of the tongue. In the beginning they are quite small, but by constant accumulation of fluid may extend until they become as large as a walnut. They vary from pink to bluish color, and give very little disturbance unless through enlargement they occasion inconvenience by interference with movements of the tongue or occlusion of the teeth.

Diagnosis.—These cysts are differentiated from hemangioma because they are more localized and the color is not so dark a blue; from lymphocysts because the latter are more irregular in form and there is a distinct difference in their contents. The author's cases have usually given history of these cysts having been more or less frequently opened or ruptured with immediate disappearance and later recurrence.

Treatment.—The author's method of treatment of mucous cysts is to inject 2 per cent. solution of cocain into the surrounding tissue. He then grasps the mucous membrane close to the border of the cyst with a forceps, to carefully follow its outline in dissection until the cyst is removed in its entirety without rupture of its thin membranous wall. Such a cyst, even of large size, when removed, should remain intact, and it should be possible to hold it in the palm of the hand with its perfect form complete. When this is done there is absolute certainty of the removal of the entire cyst, and there is no possibility of its recur-

rence. The mucous membrane edges of the wound surfaces are drawn together and sutured with gut sutures. The operation thus performed is painless and gives practically no inconvenience by reason of the few sutures that are necessary. With the continued use of mouth washes the healing takes place readily without formation of troublesome scars. Other methods, such as cauterization and curettement, are usually less effective and sometimes more troublesome.

Deep-seated Cysts of the Mucous Glands.—Deep-seated cysts of the mucous glands of the tongue arising near the foramen cecum and the third tonsil sometimes have long excretory ducts, and these cause enlargement of the parts that may be less easily distinguished because the symptoms are sometimes quite similar to those of hypertrophy of the lingual tonsil. Through contact with the epiglottis they may cause irritation and give rise to a cough easily mistaken for a symptom of some other affection.

Diagnosis.—The laryngeal mirror is necessary for diagnosis of these cysts.

Treatment.—Their removal is effected by extirpation or cauterization, whichever may be indicated by the conditions of the case.

Cysts of the Glands of Blandin-Nuhn.—These sometimes appear on the tip of the tongue.

Symptoms.—This form of cyst is rare and appears on the tip of the tongue, is quite transparent, covered with pale red mucosa, and may become so large as to be an inch or more in circumference.

Treatment.—The same as described for mucous cysts.

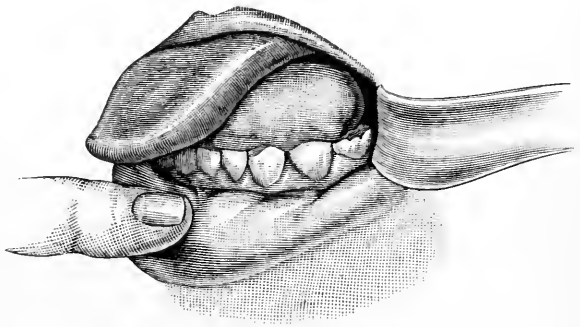


Fig. 256.—Ranula.

Ranula (Frog Tongue, Sublingual Cyst).—This is a cyst situated under the tongue. The term ranula, as commonly used, may be defined as a cyst, situated under the tongue between the frenum and the point of the jaw which displaces the tongue upward. Protest has been made by many authors against the use of this term to include mucous and other retention cysts in this region, and all agree that it should be confined to cysts of the sublingual or submaxillary glands.

Etiology.—A ranula may be congenital and due to some failure of development of the duct of the gland, or occlusion of the duct may occur at any period in life from inflammatory processes.

Symptoms.—In the early stages the swelling is confined to one side with the tongue correspondingly displaced. As the ranula extends in size it sometimes includes the opposite side of the mouth, and the swelling also appears beneath the jaw and chin. It may be pink or grayish in color, having the appearance of a bladder with the vessels in a thin distended wall quite marked. These cysts are usually filled with a light more or less viscid fluid, but this may vary under some conditions to dark brown color or may even be tinged with green or red (Fig. 256). They grow slowly and give a little disturbance, except as size increases. Sometimes a ranula may become so large as to interfere with speech and the use of the tongue; in rare instances it may cause difficulty in breathing. Large ranula in young children may alter the form of development of the jaws.

Diagnosis.—True ranula may be differentiated from mucous cysts of the floor of the mouth and tongue by difference in situation; from solid tumors, such as lipoma, angioma, and lymphangioma, or the more solid growths, by difference in consistency as well as appearance and mobility, for most tumors become more or less adherent. With one finger placed within the mouth under the tongue over the cyst and another upon the external surface under the jaw below it the free movability and fluctuation of the mass which can then be felt usually serves to make these distinctions quite evident. Confusion in diagnosis may occur when a dermoid cyst is situated just under the submaxillary gland and displaces it with the floor of the mouth and tongue upward in much the same way that these parts are displaced by ranula, and the swelling may be so great as to make it difficult to manipulate the tumor within the mouth sufficiently to make an exact differentiation. Such a case is described on p. 443 and illustrated (Fig. 263).

Prognosis.—These cysts are benign and the question of their recurrence is largely dependent on the success of the method of treatment.

Treatment.—Complete extirpation of the ranula when not too large may be accomplished from within the mouth, as described for large mucous cysts. When the ranula is of large size and the surrounding parts correspondingly displaced, it is sometimes much better to remove it by an external incision below the jaw. When extirpation is not advisable the ranula may be opened and the cyst wall destroyed by curettement. Further destruction may be accomplished with carbolic or nitric acid, and packing to encourage granulation from the bottom of the wound to prevent reëstablishment of the cyst wall.

The author's method of treating ranula (a modification of the plan suggested by Deguise) is really very simple.

Touching the mucous membrane on each side of the swelling with cocain makes the passing of a needle through from one side to the other quite painless. A wire is thus drawn through and a loop formed by

bringing the ends together and fastening with a compressed shot. The loop is bent into such form as to give the least possible inconvenience to the tongue. The natural movement of the tongue is sufficient to keep the wire loop moving slightly so that in the course of time the holes made by the wire become permanent and thus continue to serve the purpose of ducts after the wire is removed. Other methods of treatment are sometimes very troublesome. The almost immediate

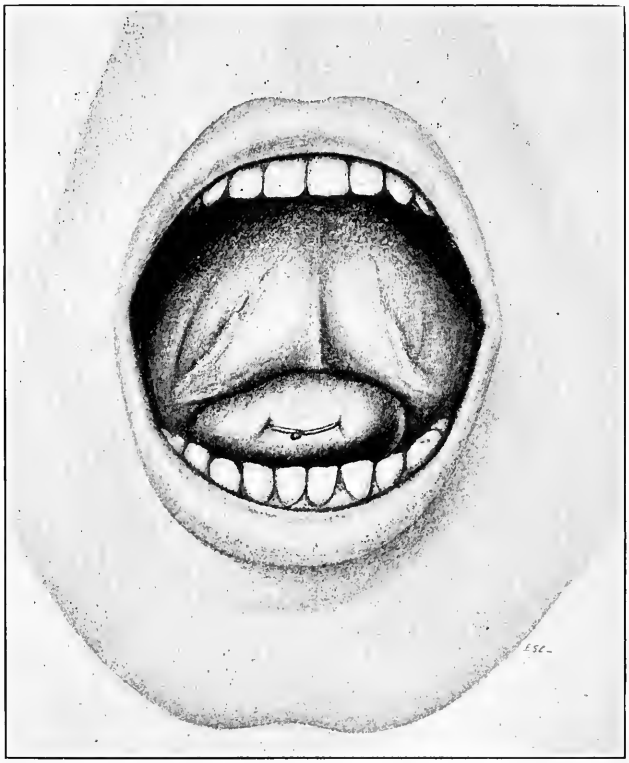


FIG. 257.—Illustration of a ranula with wire loop in place as described in the text, and performed in the case of a young girl, aged ten years and other cases. Although this girl had been operated upon several times before, the ranula never appeared again after insertion of the wire loop.

recurrence of the swelling, after it has been incised, the danger o severe hemorrhage, or distressing swelling after cauterization, and other irritating procedures are serious considerations. For example, a man who had been previously treated for several months without relief, was brought to the author, after having suffered an almost uncontrollable hemorrhage incident to an attempt to destroy the cyst by the actual cautery. In two or three minutes the wire loop was placed, the swelling immediately disappeared, and never recurred. Some months

later the wire was removed. Another patient, a girl about ten years old, was relieved instantly and painlessly by the same treatment. In this case because of frequent recurrence malignancy had been suspected. (See Fig. 257.)

Periosteal Cysts of the Jaws.—Etiology.—These cystic cavities occur in connection with roots or parts of roots of teeth, or in sites that have formerly been affected by dento-alveolar abscess from which the offending tooth root may have been extracted, but with the cavity in the bone too large to allow sufficient drainage, and thus it has become filled with fluid. In recent years there has been much investigation of the degenerative processes whereby ephitheliated granulomata become cysts through concentric degeneration of the inner part of the granuloma, and a development and proliferation of the epithelium due to chronic inflammatory conditions. Undoubtedly this occurs, but all granulomata do not necessarily form cysts. Their contents may be pus, serum, or blood if a bloodvessel in connection with the cystic formation has lost its integrity sufficiently to allow escape of blood that is retained within the walls of the cyst, thus practically converting it into a hematoma.

An example of this type of blood-filled cyst of the jaws is given in Fig. 258. The history of this cystic tumor of the lower jaw of a young man, aged twenty years, is as follows: The exact time and character of its origin was not known. It had been gradually forming and increasing in size for many years. Several unsuccessful operations had been performed for its removal. For five years past it had been opened at intervals to allow the escape of fluid contents. This gave temporary relief, but in a short time there was a recurrence. Wassermann was negative, and there was no unusual blood picture except slight indication of anemia, doubtless due to continued loss of blood. At the operation a complete extirpation was performed. The cyst and the cyst walls including the external thin bony covering on the buccal side as well as most of the bone on the lingual side of the jaw were removed from an area extending from the ramus a little above the angle, to the first bicuspid region on the opposite side. The hemorrhage was very profuse, but was easily checked, and the entire surface was cleared. The form of the jaw was retained by a continuous packing with gauze until new bone formation gave sufficient rigidity, as shown in Fig. 259. Undoubtedly the periosteum, which had been carefully preserved, was an important factor in this restoration.

The most common location of cysts of this character is in the region of the roots of the upper lateral incisors, but any part of either jaw may be similarly affected. By far the vast majority of the hundreds of cases sent to the author for surgical treatment of these cysts have been more or less directly the result of septic conditions of the lateral incisors. Pulp devitalization from traumatism, pulpitis due to exposure by caries, or other causes, lead to septic conditions that ultimately involve the anterior part of the upper jaw, in which immedi-

ately posterior to the incisor teeth there are the anterior palatine foramina and surrounding cancellous bone structure.

FIG. 258.—Radiograph of a cyst of the lower jaw.

FIG. 259.—The young man for whom the cyst illustrated in Fig. 258 and described in the text was removed. The marks indicate the extent of the jaw involvement with the exception of a little bone surrounding the anterior teeth; nearly all of the affected portion of the jaw was removed. There has been almost complete bone regeneration. The outline of both sides of the jaws is symmetrical.

Treatment such as applied by dentists through the flat, curved, or tortuous root canals of these teeth is insufficient, or it may be that the condition has been neglected, or there may have been failure to

make diagnosis of a dead pulp caused by a blow where there happened to be no carious cavity to lead to its discovery.

Symptoms.—Such cysts are painless in the absence of acute inflammatory symptoms. They grow slowly with gradually increasing thinness of the bony walls which occasionally bulge out into the mouth in marked degree. Sometimes such cysts extend into the cavity of the maxillary sinus, or may similarly involve the nose and other surrounding parts (Fig. 258).

Diagnosis.—The history of the case usually makes the diagnosis simple. There may have been devitalized teeth or roots in the vicinity of the cyst, discolored teeth without carious cavities that indicate septic pulp chambers, history of traumatic injury of teeth that have been previously diseased even though treated, and roots filled or extracted. Quite frequently there is history of repeated swelling and discharge of contents of the cyst and enlargement by outward extension of the bony wall, which is usually thin and yields upon pressure. There may or may not be a crackling sound, according to the condition of the overlying vascular supply of the bone surface. A radiogram makes diagnosis definite.

Treatment.—The treatment lies in removal of the cause. Destruction of the cyst wall, preferably with a dental or surgical engine bur, thorough curettement and packing. The advisability of extraction or treatment of the diseased root by amputation of its apical portion, and filling the root canal after methods well known to all dentists, is a question that necessarily depends upon the judgment of the operator. The retention of teeth, especially in the anterior part of the mouth, is a matter of importance. In many cases, however, their ultimate removal is necessary to prevent recurrence of the condition.

Follicular Odontomas.—These are also known as dentigerous cysts and are described on page 445, in connection with odontoma.

Proliferous or Proliferation Cysts.—These terms are used to describe formations more closely analogous to true tumors than other forms of cysts. These growths may appear in any of the glandular organs, but most frequently affect the mammary gland and ovary. The cyst cavity contains serous or gelatinous fluid, sometimes called colloid material, and occasionally the contents are hemorrhagic in character. The inner lining of the cyst may be smooth or elevated irregularly with papillary ingrowths. For this reason they are sometimes called papillomatous cystomas. These cysts may be unilocular, but are usually multilocular and contain two or more large cysts and numerous smaller cavities. Reciprocal pressure may cause more or less destruction of the septa, and numerous loculi may communicate, thus forming a cavernous cyst. The cyst cavities are lined with typical or columnar epithelium and a stroma or reticulum of connective tissue.

Multilocular Cysts.—Diseased roots of teeth, or follicular odontomas, may give rise to a form of cyst made up of many similar cysts.

These sometimes attain an enormous size (Figs. 260 and 261), which the author is able to show through the courtesy of Dr. Westmoreland, of Atlanta. In this case the multilocular cyst originated from a dentigerous cyst. These cysts are the result of embryonic inclusion of epithelial cells.

Diagnosis.—Diagnosis of this variety of cysts is simple, but the nature of these growths is not so well understood.

Prognosis.—They are close upon the border of the malignant growths. The tendency to continued proliferation and growth after incomplete removal renders such cysts a menace. McCurdy wisely calls attention to the fact that proliferating cystomas, unless completely removed, even when the remaining cysts may be almost microscopic, may cause recurrence, and that in such cases a wide and complete operation is necessary.

FIG. 260.—Multilocular cyst. (Westmoreland.)

FIG. 261.—Multilocular cyst. (Westmoreland.)

Treatment.—Removal should be as complete and effective as possible, and a large area of bone and surrounding soft tissue removed beyond the outline of the cyst when its size and situation will permit this to be done. Total resection of the involved division of the jaw is recommended by many surgeons.

Dermoid Cysts.—Dermoid cysts are congenital cysts caused by cutaneous inclusion or the inclusion of a blighted ovum.

Symptoms.—They are found in many parts of the body, such as the ovary, base of the brain, neck, etc. Our interest centers in those that are found in the neck, tonsils, pharynx, hard and soft palates, the floor of the mouth, and dorsum of the tongue. They vary considerably in size. On account of the epithelial lining of the cyst, hair, teeth, and sweat glands are not unusual contents. According

to Brummell,[1] the hair may be several feet long, and it is usually of light brown color. He also claims that it whitens as the outer hair becomes white. Occasionally they contain bone and cartilage, an indication that connective-tissue products are also present, which points to fetal occlusion. These are called *compound dermoids,* to distinguish them from *simple dermoids,* in which no connective-tissue elements are present, and Coplin believes this form should entitle them to be classed with *teratomas.*

Quite frequently the cyst wall is very thin (Fig. 262), and filled with more or less oily contents.

FIG. 262.—Portion of a wall of an ovarian dermoid cyst; *a*, wall of the cyst; *b*, projecting portion made up of fatty and cutaneous tissue; *c*, hairs; *d*, teeth. (Ziegler.)

The tumor shown in Fig. 263, before removal by the author, is interesting because it illustrates the difficulties of diagnosis that sometimes occur in these cases. The situation of the tumor was such as to force the floor of the mouth and the inferior maxillary gland up until the tongue was almost completely turned over to the other side of the mouth. A history of what was claimed to be surgical removal (an error, of course, because whatever other structures may have been operated upon the growth itself was not disturbed) and recurrence complicated the diagnosis. Palpation within the mouth was difficult on account of displacement. The submaxillary gland could be felt close to the surface, and for a time, in view of the history given, it was thought to be a tumor of this gland. Incision following the lower border of the jaw and another one just anterior to the sternocleidomastoid muscle made it possible to expose the mass and enucleate the cyst with little difficulty. Recovery was complete and uninterrupted.

[1] Dental Cosmos, 1905.

Prognosis.—These cysts are chiefly of interest because of their possible explanation of unusual conditions that from time to time arise in and around the buccal cavity. But they are benign, and except when of large size and in dangerous situations removal is a comparatively simple matter.

FIG. 263.—Dermoid cyst of the neck.

Parasitic Cysts.—Echinococcus Cysts.—In rare instances hydatid cysts have been found in the mouth caused by Tænia echinococcus or *dog tapeworm*. These usually gain entrance in the intestinal tract, and in rare instances form cysts in the buccal mucous membrane.

Bertelá and others report finding these cysts in the temporal and masseter muscles.[1]

ADULT EPITHELIAL TUMORS.

Odontoma.—An odontoma is a tumor composed of one or more of the dental tissues arising either from tooth changes or teeth in process of development.

Etiology.—The causes are perversion of development leading to diversion of the structures or cellular elements from which tooth germs are developed resulting in abnormality of form and character through which several kinds of tumors occur.

Classification.—Broca divides odontomas according to the stage of development of the dental follicles at which they occur. In the first or *embryoplastic* stage the tumor developing in the dental sac when the latter is composed of mucous tissue results in a pure myxoma. When connective tissue is included it results in a fibrous odontoma.

In the second or *odontoplastic* stage soft tumors may occur, but these have a tendency to become hardened.

The *third* period results in tumors the composition of which repre-

[1] Bulletin of von Bergmann, p. 521.

sents calcified tooth structures. When occurring in this stage the tumor is composed of structure resembling calcified tooth structures. These are subdivided into crown and root formations, and may be still further distinguished by indicating whether composed of enamel, dentin, or cementum, or a composite combination of these.

Sutton's classification, which will be used in further description, is designed to distinguish the several forms of odontoma. Clinically the essential difference lies in differentiation between the forms which result in soft tumors and those of hardened tooth structure, and in considering diagnosis and treatment this general division is the one principally required.

Odontoma forms a notable example of the exceptions that must necessarily occur in all tumor classifications, viewed in the light of our present imperfect knowledge of true etiology. It is true that teeth are developed from epiblastic and mesoblastic structures, and for this reason odontoma cannot be classified with the epithelial group in a strict sense. On the other hand, it is of the adult typical type, and for this reason it does not seem advisable to classify it with the teratoma or mixed epithelial and connective-tissue tumors, because these are both adult and embryonic, whereas the odontoma is adult and therefore benign. Sutton classifies the different forms of odontoma as follows

Epithelial Odontoma.—These develop from the remains of the epithelium of the original enamel organ.

Symptoms.—They appear in the form of a series of cysts separated by thin septa and contain mucoid fluid. The color during growth is slightly red and not unlike sarcoma.

Follicular Odontoma or Dentigerous Cysts.—*Etiology.*—They usually form in connection with developing permanent teeth.

Symptoms.—The bony walls become thin from the formation of fluid within the cyst and sometimes bulge out in such manner as to cause great deformity. The inner wall of the cyst represents the remains of the dental follicle within which in every instance there is a tooth or part of a tooth. The cyst is filled with fluid, usually serous or mucoid, but occasionally of dark brown color. Ordinarily these do not become purulent, but occasionally through infection this does occur, and may result in severe inflammatory conditions (Figs. 264 and 265).

Fibrous Odontomas.—Fibrous odontomas are developed from the connective-tissue elements of the developing tooth by excessive growth of the fibrous capsule of the tooth germ which is derived from and closely adherent to the connective tissue of the papilla.

Symptoms.—The tumor has a firm outer wall with less firmly connected inner structure, which blends at the root of the tooth with the dental papilla and is indistinguishable from it. In this way the developing tooth becomes enclosed within the capsule. These tumors are quite frequently seen in animals, especially ruminants, etc. (Fig. 266).

Cementome.—This is a tumor in which by calcification of the capsule the tooth becomes embedded in a mass of cementum.

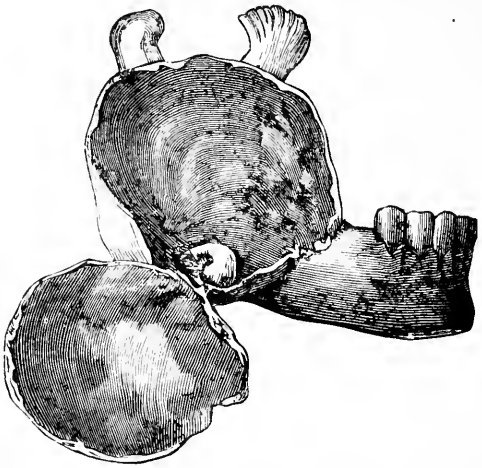


Fig. 264.—Cyst of the lower jaw, having its origin about an undeveloped tooth. (Garretson.)

Fig. 265.—Denta cyst, lower jaw.

Symptoms.—Cementomes sometimes attain great size. Their structure resembles cementum, and is arranged in layers somewhat

similar to fibrous odontomas. They are rare in human teeth and usually occur in the mammalia. Marshall reports a tumor in the mouth of a horse five and three-quarters inches by four and one-quarter inches in size, which ultimately caused the death of the animal.

FIG. 266.—Fibrous odontome. (Garretson, after Pierce.)

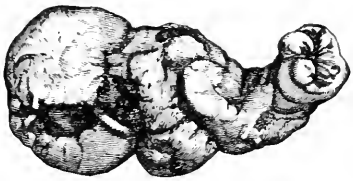


FIG. 267.—Radicular odontome. (Tomes.)

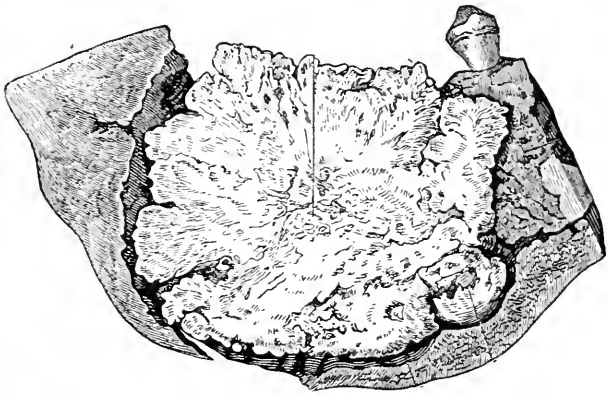


FIG. 268.—Composite odontome.

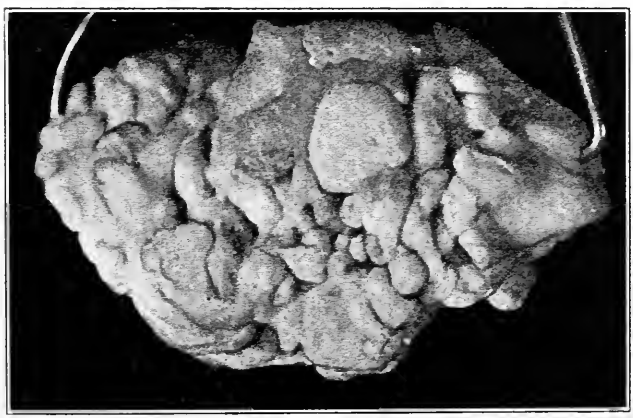


FIG. 269.—Composite odontome. (Gilmer.)

RADICULAR ODONTOMAS.—These tumors form after the development of the crown and during the process of root formation. They

consist of cementum and dentin in varying quantities, are rare in men, but frequent in animals (Fig. 267).

Composite Odontomas.—These are abnormal growths of all the elements of tooth structure, resulting in ill-deformed masses of cementum, dentin, and enamel. Thus far they have only been found in man (Figs. 268 and 269).

Compound Follicular Odontomas.—The follicle wall becomes thickened into a fibrous capsule. In this there may be portions of dentin, enamel, or cementum. Imperfectly or more or less imperfectly formed teeth are all together a heterogeneous mass. Fig. 270 shows photograph of a compound follicular odontoma which contained eleven teeth (Dr. Weeks' case). Rudimentary or other teeth have sometimes been found in very large numbers; as many as several hundred have been taken from the jaws of one person.

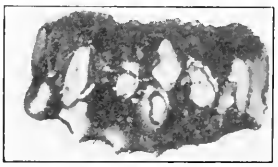


Fig. 270.—Compound follicular odontoma.

Diagnosis.—Myxomatous and fibromatous forms of soft odontoma, both of which are formed during the embryoplastic or odontoplastic periods, are frequently difficult to differentiate from other tumors of the jaw, notably cysts, fibroids and sarcoma.

The diagnostic guides are slow growth, freedom from pain, irregular surface; on section, masses of cement or dentin may occasionally be found to be encapsulated.

Of the hard forms, dentigerous cysts are usually discovered by the yielding of the thin bulging wall on pressure, with perhaps a crepitant sound; puncture to reveal the character of the fluid contents, and on opening a tooth is revealed in cystic enclosure.

Radicular odontoma, cementome, or composite odontoma can usually be diagnosticated with sufficient accuracy to determine that the growth is not bone by passing a sharp, light steel probe through the overlying tissues until it comes in contact with the smooth, dense, more or less irregular surface of the tumor, which is recognized by sense of touch.

This much understood and some form of odontoma looked for, its exact character may be determined after removal.

When doubt exists in differentiation between soft odontoma and malignant growths, sections prepared for the microscope must be depended on for the final distinction. As there is always a possibility of benign growths assuming malignant form, such examination should be made as a precautionary measure, even when there

may be reasonable certainty that no such complication exists. It is the author's custom as a matter of routine practice to have even bony enlargements in the vicinity of impacted teeth or odontoma decalcified and submitted to microscopic examinations, as well as surrounding portions of soft tissue. It has often happened in his experience that the former sites of these apparently benign conditions have given rise to both sarcomatous and carcinomatous growths.

Differentiation from odontoma and exostosis is sometimes rendered difficult because of the extreme density that these bony formations acquire. Actinomycosis or chronic bone diseases, such as tuberculosis, syphilis, and other affections in which there are alterations in the external form of bone surfaces with tendency to bone abscess, are best distinguished by bacteriological examination of the contents of the cyst and consideration of the symptomatology of the suspected disease.

In the diagnosis of all forms of odontoma, radiographs are advantageous, as such tumors show plainly in such pictures, and the operation is often simplified by exact knowledge of the size and form of the odontoma before removal. Great care should be exercised to determine with certainty that any growth of similar appearance upon or in the jaws is not an odontoma or other benign tumor before radical excision is performed for a supposed malignant neoplasm. Such errors have not infrequently occurred.

Prognosis.—Odontomas are benign, and the prognosis is generally favorable, but inflammatory necrotic or malignant processes may follow in their wake. If completely removed, with thorough extirpation of the epithelial and connective-tissue elements, there is no tendency to recur. This is especially necessary with compound follicular odontomas.

Treatment.—The treatment of odontoma of every variety is complete removal of the growth, destruction of the cyst walls, and postoperative treatment designed to allow the wound cavity to fill in by granulation.

Almost always these operations can be thoroughly and sufficiently performed from within the mouth, and this should be done whenever possible. Occasionally the situation of the growth is such as to make external incision not only more effective but more direct, and therefore much simpler. Dentigerous cysts require the removal of the external wall as completely as possible, and the cystic cavity should not only be freed from its contents, including the encysted tooth elements, but the entire cyst wall should be destroyed at every point. It is the author's practice to accomplish this thoroughly with a surgical or dental engine bur, with which walls, both bony and membrane of the cyst, can be quickly and completely removed. The cavity thus converted as nearly as possible into a saucer-shaped form is easily packed. It may be expected to fill in by granulation from the bottom without danger of the external opening, closing first, as some-

times happens when too small an opening is made, and thus causing a recurrence of cystic conditions.

Papilloma or Wart Tumor.—This form of growth, formed from cutaneous and mucous papillæ, consists of a fibrous stroma or stem containing bloodvessels and lymphatics covered by an epithelial investment.

Etiology.—Chronic irritation with a low-grade inflammatory process as generally accepted is the most common cause. Irritating discharges, as from diseased conditions and especially from genital and anal borders, are also etiological factors. In the mouth, rough or sharply projecting tooth borders, ill-fitting crowns and bridges imperfect interproximate spaces due to carious cavities or ill-fitted fillings, or artificial dentures and similar conditions leading to local irritation, may cause papillomatous growths. In addition to all of the recognized forms of irritation which cause papillomas there appears to be some other not understood reason for their spontaneous appearance without recognizable external causes.

Varieties.—(1) Skin warts. (2) Villous warts. (3) Intracystic warts.

Skin Warts.—Skin warts are overgrown papillæ with the epithelium passing from one papilla to another in unbroken line without invading the fibrous framework. They may be single or multiple, vary in color by becoming mottled with black pigment, attain great size, and become cystic.

Symptoms.—Papillomas have a structure of connective tissue with an epithelial covering which passes from one papilla to another in an unbroken line without invading the fibrous framework, and this has led to some confusion in classification.

They present the appearance of ordinary warts, and may be single or multiple. They are usually sessile, but may assume a cauliflower appearance. They are of variable size, occasionally very large, and of different color through pigmentation, and may become cystic.

Soft Warts.—The papillomas that form upon mucous membrane usually have a cauliflower appearance. About the genitalia they sometimes become exceedingly prolific, and are called mulberry growths.

Villous Papilloma.—Villous warts are usually found in the bladder, pelvis of the kidney, and similar situations.

Symptoms.—They appear in the form of long feathery tufts, have a connective-tissue core, which is filled with bloodvessels, and are covered by epithelium.

They may be single, multiple, sessile, or pedunculated. Serious hemorrhage and even death has been known to result from rupture or detachment of a villous papilloma.

Intracystic Villous Papilloma.—Intracystic warts occur within cysts lined with epithelium in glands such as the mammary, ovary and thyroid.

PLATE XI

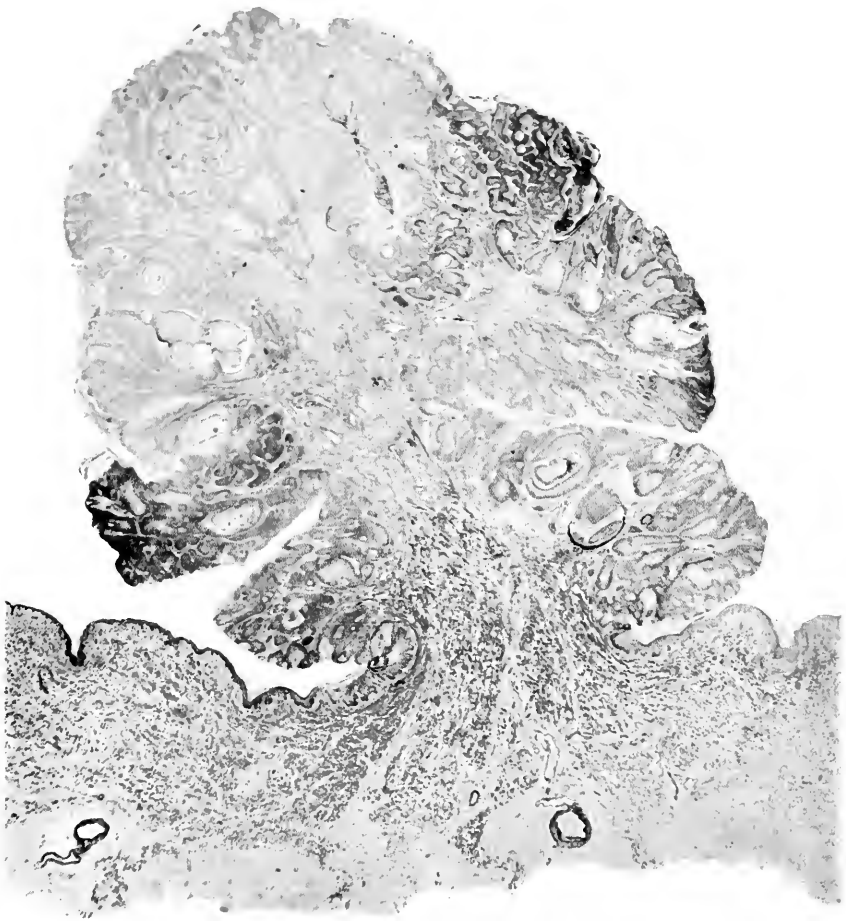
FIG 1

Papilloma of the Tongue.

FIG. 2

Papilloma of the Gum.

PLATE XII



Photographic Reproduction of Papilloma. Low Power. (Gaylord.)

Cutaneous Horns.—These are epithelial growths and, according to Sutton's classification, are met with in four varieties:

1. *Sebaceous horns* are formed by the contents of sebaceous cysts exposed to the air by rupture or disease and dried with progressive extension of the growth as the process is continued.

2. *Warty horns* which grow from warts instead of sebaceous glands. These growths usually occur about the head or face, and are much more common in the lower animals than in man.

3. *Horns growing from cicatrices,* extensive growths, from the cicatrices of burns have been reported.

4. *Wart horns* are overgrown nails upon the fingers and toes of individuals who from any cause have become incapacitated and unable to use the parts.

Symptoms.—Rare and somewhat famous cases of horns of unusual length have been reported and illustrated in many text-books, showing growth of twelve or more inches, and nails of unusual length. Interesting as these may be, the really important aspect of this subject for our present purpose lies in the papillomas so frequently found in the buccal cavity which require careful differentiation from malignant growths.

Symptoms of Papillomas of the Mouth.—These growths are frequently found upon the dorsum of the tongue, the buccal surfaces of the cheeks, the gums, particularly in the vicinity of ill-closing, interproximate spaces, and the soft palate. They may be small or increase until their size becomes a matter of serious inconvenience. The cauliflower form may or may not be evident. The color is red, pink, or grayish. The growth is usually quite firm, and sometimes might be termed hard when covered by squamous epithelium (Plates XI and XII).

Prognosis.—Papillomas are benign growths, and once completely removed show no tendency to recur. The danger, as has already been indicated, lies in their occasional tendency to become transformed into sarcomas and, particularly when occurring upon the tongue, into cancer. When growths occur in the latter and the urethral orifice, rupture of the delicate connective-tissue matrix causes serious or fatal hemorrhage.

Treatment.—Complete extirpation is the only trustworthy remedy. The growth should be removed down to and including the periosteum, and in order to be safe, tissue should be excised a little beyond the line of demarcation of the growth at all points.

The possibility of development of malignant characteristics in these growths should be borne in mind, and the microscope depended upon to make the final diagnosis of a benign condition, or the reverse.

Figs. 271 and 272 are examples of many cases in the author's practice, all of which were difficult to distinguish from sarcoma until the verdict of the microscope settled the question. Subsequent history has confirmed the findings.

Adenoma.—This form of tumor is constructed upon the type of a gland without power to produce the secretion peculiar to the gland tissue or type from which it springs, and it has no ducts that com-

FIG. 271.—Papilloma of the gum.

FIG. 272.—Papilloma of the gum.

municate with the normal gland. They are benign, but contain both connective tissue and epithelial cells, which renders transformation into sarcoma and carcinoma not only possible but extremely likely. They may develop in any glandular structure, and may contain any glandular tissue.

Classification.—The two principal varieties are:

1. *Acinous Adenoma.*—These are tumors having acini lined with small epithelial cells. The acini communicate with each other, are grouped together, and separated by a connective-tissue matrix containing bloodvessels. This form is exceedingly rare, but fibro-adenomas are quite common.

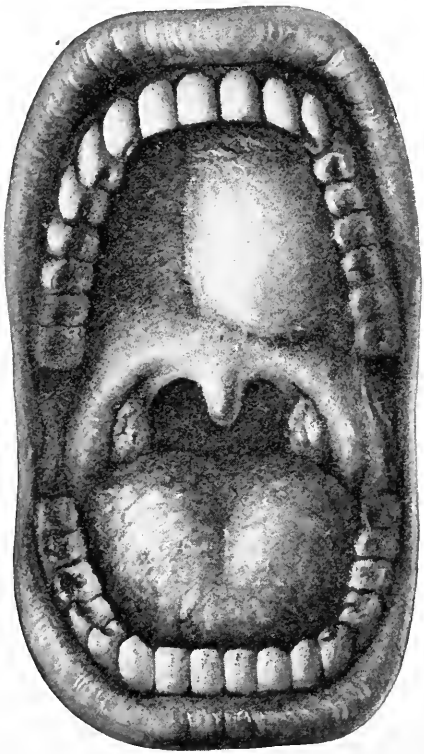


FIG. 273.—Unusual epithelial tumor of the palate. (After New.)

2. *Tubular Adenoma.*—This form is quite commonly found in mucous membranes possessing tubular glands. It is soft, slightly translucent, and somewhat vascular, and exceedingly likely to become malignant.

The chief species are mammary, sebaceous, thyroid, prostatic, parotid, hepatic, renal, ovarian, testicular, gastric, Fallopian, and uterine.

Etiology.—Their origin is believed to be due to some quiescent congenitally displaced rudiment. Irritation doubtless plays some part in the causation of these as with other tumors.

Symptoms.—Adenomas of the mucous membrane of the mouth usually occur upon the lower lip and cheeks in the form of smooth, firm, nodular enlargements beneath the mucous membrane, but slightly adherent. They are usually encapsulated, are not painful, grow slowly, and except in rare instances give slight inconvenience, unless when in the course of years they attain unusual size, or ulcerate

Fig. 274 (same as Fig. 273).—Areas showing the cells' nests. In other areas the central part of the nests has dropped out, leaving the outer layer of cells. (After New.)

or assume malignant character. Occurring as they sometimes do upon the soft palate, the sound of voice or breathing may be more or less affected. Such tumors may attain the size of a hen's egg. They are occasionally found at the base of the tongue or near the foramen cecum. These, as reported by Wolff, Chamisso de Boncourt, Benjamin, Watson, Tewels, and others, were all discovered in young women. They were invariably situated in the median line, with a smooth, slightly notched surface, elastic, and with vascularity well marked.[1]

[1] Von Bergmann: System of Practical Surgery, i, 859.

They have been found to contain thyroid tissues, and have been termed *accessory thyroid tumors*.

Differential Diagnosis.—Adenomas must be differentiated from glandular enlargements, which are simply an increase of natural glandular elements, from retention cysts, and inflammatory conditions. The distinction between adenoma and carcinoma is often very slight.

"As soon as the epithelial cells lose their regularity of disposition and collect in groups, or make their way outside of the acini into the tissues, then the change from the benign to the malignant tumor has begun, and the entire clinical aspect of the case is altered. This change may be the result of external irritation, of such tissue changes as pregnancy and lactation, or of the undivided changes which advancing years seem to produce."[1]

FIG. 275.—Adenoma of the palate of a young woman. There was no recurrence after its complete surgical removal, which was accomplished without entering the nasal cavity.

Prognosis.—With true adenoma the prognosis is favorable and there is little if any likelihood of recurrence.

Treatment.—The extirpation of the growth is usually effected through the mouth. At the base of the tongue under unusual conditions some of the operations described (pages 537 and 539) for removal of growths in that region may be required.

Neuroma.—A neuroma is a tumor consisting almost entirely of nerve tissue.

Varieties.—The term, used in a strict sense, applies to a very rare form of tumor, but as commonly applied includes tumors containing nerve elements and fibrous tissue. These are more properly termed

[1] Park, Modern Surgery, p. 284.

false neuromas. *Plexiform neuromas* appear in the form of nodules along the course of the nerve or in a nerve plexus (Fig. 276.)

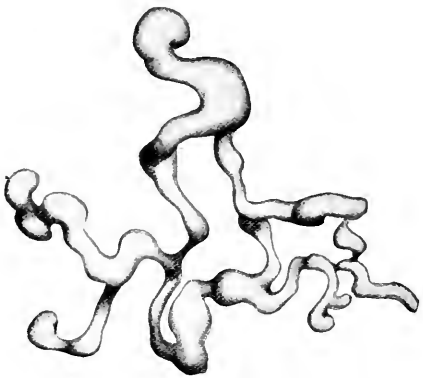


FIG. 276.—Plexiform neuroma, dissected free from all adherent tissues. (Lexer.)

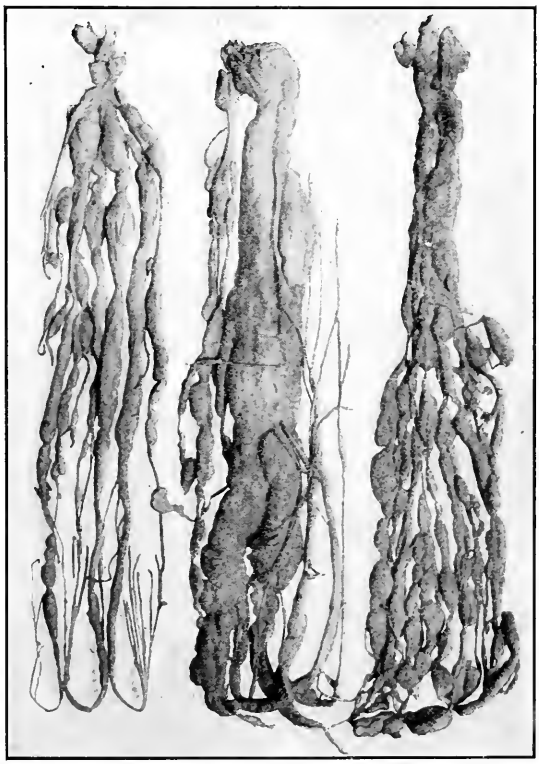


FIG. 277.—Multiple neuroma. Nerves of the arm, the lumbar plexus, and the sciatic nerve. Specimen from the Museum of the College of Physicians and Surgeons. (Starr.)

Ganglionic neuromas are tumors composed of or containing ganglion cells. *Myelinic neuromas* contain newly developed medullated fibers. *Amyelinic neuromas* are formed of non-medullated nerve fibers. These belong to the false neuromata because the new tissue is fibrous.

Etiology.—The causes of neuromas are injuries to the nerves, such as amputation, which leads to *amputation neuromas* or bulbous masses at the cut ends of nerves. Heredity is supposed to be accountable for the multiple fibromas of superior superficial nerves.

Symptoms.—Both the cranial and spinal nerves are subject to this affection. Park believes the sensory nerves are more likely to become attacked than the motor. The nerve least often attacked is the optic. The fifth nerve, through operations for neuralgia and by reason of exposure to injury at various points, is subject to nerve tumor. Pain, loss of sensation, paralysis, or muscular spasm may be objective symptoms according to the nerve or nerve branch that may be involved (Fig. 277).

Prognosis.—Neuromas are benign growths, but many of them are sarcomatous from the beginning, and in others malignancy is developed as the growth proceeds. The result of treatment will, of course, be dependent upon the situation of the tumor and the nerve affected and the character of both.

Treatment.—Excision is the only remedy when the exact location of the tumor can be determined, providing its situation is such as to make operation possible. The paralysis following operation upon the nerve trunk may sometimes be overcome by nerve suture, grafting, and similar treatment.

Glioma.—Gliomas are tumors derived from the sustaining tissue of the central nervous system (the neuroglia) and composed of glia cells, more or less closely maintaining the normal elements. The sites of these tumors are the brain and cord, optic nerve and retina, olfactory lobe. They therefore do not require description among the tumors of the mouth.

ADULT CONNECTIVE-TISSUE TUMORS.

Lipoma or Fatty Tumor.—Etiology.—Heredity seems to have a marked influence. Multiple lipomas have been known in families, and inherited tendency has been transmitted through several generations. In some cases the tumor is congenital.

Varieties.—The principal varieties are: *Encapsulated*, enclosed in an exceedlingly thin capsule, and *diffuse*, when the margins are not clearly defined.

Symptoms.—These growths are rarely found in the mouth. Knack, upon a study of the literature, collected reports of 29 cases of lipoma in the oral cavity, 12 on the tongue, 9 on the floor of the mouth, 7 on the lips, and 1 on the gums and soft palate.[1]

[1] Von Bergmann: System of Practical Surgery, i, 156.

"In the mouth these growths are usually under the mucous membrane of the floor of the mouth and originate deep within the muscular layers. The overlying mucous membrane is not adherent, and the light yellow color of the lipoma can be indistinctly seen through the altered mucous covering.

"*Lipomata of the cheek* are situated in the submucous layer and easily distinguished from large lipomata of the skin."

Prognosis.—They are benign and do not recur unless of mixed nature.

Treatment.—This consists in complete extirpation.

Chondroma (Enchondroma, Enchondrosis, Chondroid, Chondroid Exostosis).—This tumor is composed largely or entirely of cartilage.

FIG. 278.—Gum tissue from the region of an impacted lower third molar, showing cartilage formation.

Etiology.—Congenital tendency appears to be hereditary in some cases. Irritation as a causal factor is indicated by formation of cartilage in the tendons of muscles subject to frequent irritation and traumatism by outgrowths of cartilage from bones that have been injured or fractured. According to Virchow,[1] chondromas often spring from remnants or islands of cartilage left in abnormal situations.

Varieties.—(1) Cartilaginous outgrowths, ecchondrosis or ecchondromas. (2) Cartilaginous tumors or true chondromas which originate in non-cartilaginous structures.

Symptoms.—The tumors occur most frequently on the metacarpal bones and phalanges of the hands, less frequently in other long bones,

[1] Stengel: Text-book of Pathology, p. 154.

and somewhat rarely upon bones of the face. They are not infrequently found in soft parts, as the tendons of muscles, salivary glands, tonsils, and other glands of the body. In rare instances metastases have been known to occur in the lungs, spleen, brain, liver, and heart as reported by Michaeloff[1] who collected 14 such cases.

Prognosis.—The prognosis is good. The tumor is benign, grows slowly, does not recur after removal, and has almost no tendency to metastasis; mixed forms of cartilaginous tumor which are quite common may present a more serious aspect. Fig. 278 is an illustration of gum tissue in the region of the third molar tooth that shows the beginning of such a growth.

Treatment.—Surgical removal is indicated whenever the situation or threatening aspect of the tumor requires such treatment.

FIG. 279.—Osteoma of the lower jaw.

Osteoma.—Osteoma is a tumor composed of bony tissue.

Etiology.—Unusual stimulation of the periosteum by irritation, traumatic injury, or diseased conditions are among the causes.

Varieties.—*Exostosis,* growth from the external surfaces of the bone. *Enostosis,* growth from the internal structure of the bone. These may be *eburnated,* or very hard, *compact,* or similar to compact bone structure, and *cancellous* or spongy.

Symptoms.—They are most commonly found in connection with the periosteum of bone, medulla or cartilage, but also occur in soft parts of the body, as in the brain structures, diaphragm, coat of the eye, air

[1] Coplin: Manual of Pathology, p. 340; Quotation from Patel: Rev. Chir., March 10, 1904, p. 398.

passages, lymph nodes, nerve centers, and tendons.[1] These may give much or little trouble, according to their situation, may grow into the interior of the skull, the frontal or other sinus, the cavity of the orbit or the nose. In such situations they may give rise to disturbance; otherwise they are painless and grow slowly. They sometimes lead to inflammatory conditions resulting in necrosis and more or less extensive loss of bone structure.

Prognosis.—The prognosis is good, although the question of recurrence is necessarily dependent upon correction of the exciting cause, as well as removal of the growth. Occasionally such tumors become carcinomatous.

Treatment.—Treatment consists in removal. Complete excision of the affected bone. Fig. 279 shows a section of an osteoma of the lower jaw in a woman, aged forty-nine years, excited by an impacted unerupted tooth.

Fibroma.—Fibromas are tumors composed of wavy bundles of fibrous tissue.

Etiology.—The causes of fibroma, as of other tumors, are more or less enshrouded in mystery, but clinically the influence of irritations is an important factor. This is shown by the frequent development of fibromas in old scars or situations that have been exposed to injury or chronic irritation.

Symptoms.—Fibroma may be hard or soft and occurs in many different situations and structures of the body, but most commonly in the ovary, uterus, the intestines, the gums, nerve sheaths, and skin. Hard fibroma is usually oval and globular, smooth, movable, and painless, unless attached to a nerve. The soft fibroma is very similar except that it is more yielding and elastic. Pure fibroma is somewhat rare. Most fibromas are in combination with other tissues. Simple fibroma of the skin presents a nodule about the size of a pea, is of firm consistence and situated loosely in the tissue immediately under the integument. These are exceedingly painful.

Neurofibromatosis is a rare condition in which there is overgrowth of fibrous tissue in connection with nerves. *True keloid* is most common in the negro, and is composed of bundles of coarse fibers in the chorium, the papillæ and epidermis being intact.

Cicatricial keloid develops in the substance of a scar, and is not covered by the papular layer. It is the *bête noir* of surgeons, as it occurs in the scars of sutures and wounds that in the beginning may have been very slightly noticeable and shows a tendency to recur after it has been removed (Fig. 280).

Prognosis.—The prognosis is good. They do not recur after removal, do not give rise to metastasis, and unless in combination with malignant growths are not dangerous except through pressure upon the vital parts or interference with the function of important organs.

[1] Coplin: Manual of Pathology, p. 341.

Treatment.—Surgical removal is being generally supplanted by *x*-ray or radium treatment, which in cases such as those illustrated in Figs. 281 and 282 will insure a better result without fear of creating noticeable deformity.

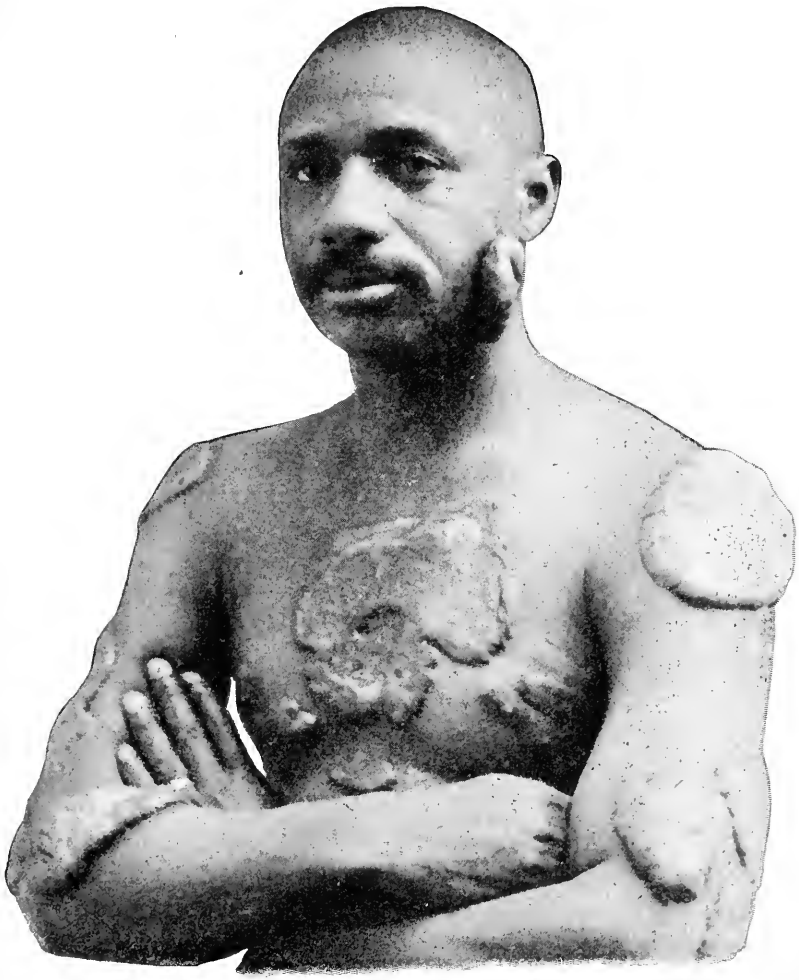


FIG. 280.—Keloid. (Hardaway.)

Myoma.—Myomas are tumors composed of muscle tissue; strictly speaking, a leiomyoma or myoma levi cellulare, or when composed of non-striated muscle fiber, because many modern writers discourage the use of the term "rhabdomyoma," used to describe tumors of striped muscle fiber, because this exceedingly rare form, usually found in the kidney and the uterus, is seldom or never a true myoma.

Etiology.—As with other tumors, there is indication in some of misplaced embryonic elements, and in others irritants appear to have an undoubted part in causation.

Symptoms.—They are commonly found in the gastro-intestinal tract, uterus, and skin, and according to Coplin are also found more or less frequently in the tongue. They may be very small nodules or of enormous size, weighing 60 to 70 pounds. Williams reports one removed by severance weighing 195 pounds. They may be single or multiple, and when arising from submucous or subserous tissue may be polypoid and hang by a small pedicle. They are surrounded by a capsule and quite hard unless altered by secondary degenerations, which may be cystic or calcific, with corresponding alteration in the character and growth.

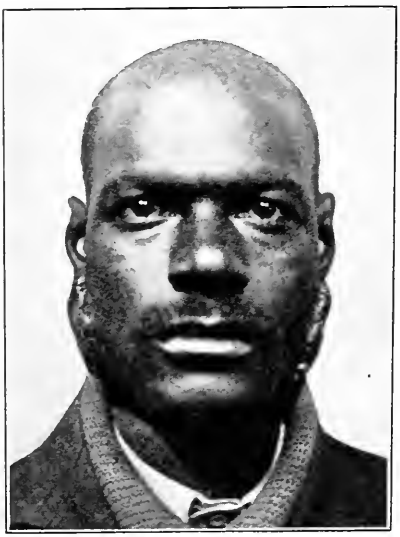


FIG. 281.—Negro with keloid on both cheeks. (Surgical Clinic of the Southern Dental College, Atlanta, Ga.)

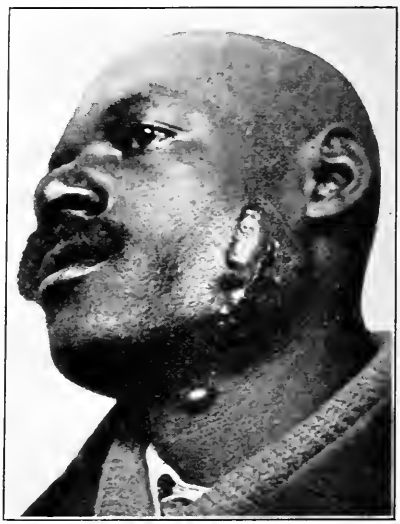


FIG. 282.—Side view of negro, showing keloids on cheek and neck. (Surgical Clinic of the Southern Dental College, Atlanta, Ga.)

Prognosis.—They are benign and grow slowly. Their only dangerous features occur through interference with other parts by reason of their enormous size and the pressure sometimes occasioned, and through degenerative changes, to which they are quite subject.

Treatment.—The treatment consists in surgical extirpation.

Angioma.—Angiomas are tumors composed of bloodvessels. Coplin uses the term angioma, and includes both blood- and lymph-vessel tumors, distinguishing the bloodvessel tumors by the term hemangioma.

Classification.—1. *Capillary Angioma* (Nevus, Port-wine Marks, Telangiectasis).—It is usually congenital. They appear upon the skin and subcutaneous tissue in all parts of the body, on the surface

and the submucous surface of the tongue, inside of the mouth, conjunctiva, and in similar situations. Sometimes they spread over a relatively large area.

FIG. 283.—Angioma of the lip. (Westmoreland.)

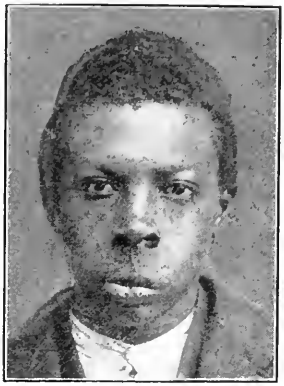


FIG. 284.—Same boy shown in Fig. 283 after operation. (Westmoreland.)

2. *Cavernous angiomas* are sometimes called erectile tumors. They are occasionally found in the tongue, voluntary muscles, larynx, and thyroid, but chiefly upon the skin, and are exaggerated forms of capillary angioma (Fig. 285).

FIG. 285.—Angioma of the gum and palate. (Campbell.)

3. *Arterial or Plexiform Angiomas.*—In these arteries of unusual number and character occur in the scalp, occasionally the perineum, but rarely in other parts of the body.

Diagnosis.—The diagnosis of angioma is, as a rule, quite simple. The discoloration of the skin, recession of blood upon pressure and murmur usually make recognition quite plain. In the mouth, however, these tumors are not always easily differentiated. The author has had

many cases like the tumor from an edentulous portion of the alveolar ridge of the lower jaw of a woman of middle age. Its appearance was not unlike other tumors found in similar situations. The history of repeated removal and recurrence confused the diagnosis until cleared up by the microscope.

Prognosis.—The prognosis is good. They are benign, but frequently become the seat of malignancy.

Treatment.—Surgical removal when the vessels are much dilated must not only include a careful dissection of the tumor, but ligation of the deeper vessels of supply to prevent recurrence and to check immediate hemorrhage.

The smaller forms may be successfully treated with the electric needle, depending upon coagulation of the blood, organization of a thrombus, and formation of cicatricial tissue as a result of the effect of the electric current. Within the mouth, it is the author's belief that the most effective way in many cases is by the use of the actual cautery. The ligation of vessels supplying the part for the purpose of cutting off the blood supply and causing gradual reduction of the tumor is not so often employed at the present time as formerly. The disfiguring effect of nevi upon the face is sometimes overcome by removal by careful dissection of the affected skin surface and the grafting of new skin upon the denuded area. More recently the *x*-rays have been used with reported good results in some cases, also the actinic rays of the Finsen lamp. The latest encouragement, however, comes from the use of liquid air and carbon dioxide snow.

Fig. 286.—Macroglossia. (Westmoreland.)

Lymphangioma.—Lymphangioma is a tumor composed of dilated lymph vessels or lymph spaces.

Classification.—There seems to be some confusion among authors with regard to the distinction in classification of the varieties of lymph tumor. It is sufficient for our present purpose, however, to recognize the following principal forms:

Elephantiasis congenita mollis, in which the subcutaneous tissues are edematous and may contain distinct cystic formations, as in congenital enlargement of the tongue.

Congenital cystic hygroma is a cystic formation of the lymph spaces.

Macroglossia or lymphangioma of the tongue. Sometimes the tongue is so large as to protrude from the mouth, as shown in Figs. 286 and 335, p. 541.

Macrocheilia is the same affection of the lip as shown in Figs. 368 and 369, pp. 573 and 574.

Nevus lymphaticus, small, closely aggregated, deep-seated, transparent vesicles varying from a pinpoint to that of a hemp seed. When picked, lymph or blood-stained lymph flows from them.

FIG. 287.—Lymphangioma of tongue. Girl, aged twelve years, treated at the Mayo Clinic and reported by Dr. Gordon B. New. She was treated with radium for two hours daily with the 22-mg. tube, with no screening, for a period of twelve days. Previous *x*-ray treatments had made no improvement.

Symptoms.—The symptoms consist in congenital enlargement of certain parts which appears to be entirely due to abnormal development of lymph spaces.

FIG. 288.—Tongue of same girl shown in Fig. 287 after treatment.

Treatment.—Surgical removal when necessary is indicated. In case of the tongue it is advisable to remove a portion, and if possible to preserve the organ in such form as to enable it to fit properly within the mouth.

Gordon B. New, of the Mayo Clinic, reports the successful treatment of lymphangioma of the tongue with radium. He prefers radium treatment to surgical measures, because excision of the tongue tissue is so likely to leave that organ stiff and board-like from scar formation. (See Figs. 287–290.)

Macrocheilia requires exceedingly careful operative treatment to remove the unusual thickness of the lip and yet preserve the cosmetic effect of the border of the prolabium without stiffening the lip or altering its appearance during speech and laughter.

Lymphoma.—Lymphoma is a tumor of the lymph node. This term is applied to the glandular enlargements of tuberculosis, syphilis, and other infectious diseases. They are usually apparent in the lymph nodes of the neck, groin, and maxilla. The character of the disease is, as a rule, indicated by such terms as syphilitic lymphoma, tuberculous lymphoma, etc.

Treatment.—Treatment is that of the local treatment of an inflammatory process and that of the disease by which it is caused.

FIG. 289.—Lymphangioma of the tongue of a boy, aged two and a half years, treated at the Mayo Clinic and reported by Dr. Gordon B. New. He was treated two hours daily with a 28-mg. tube of radium, unscreened, for a period of ten days.

FIG. 290.—Same boy shown in Fig. 289 after treatment.

Lymphadenoma (Hodgkin's Disease, Pseudoleukemia).—Lymphadenoma is a malignant newgrowth.

Etiology.—It was generally accepted as being sarcomatous, although there were many reasons for assuming that it is sometimes of tubercular origin until Bunting and Yates discovered the B. hodgkini as described on p. 428.

Symptoms.—In the beginning, painless enlargement of the lymph nodes of the neck occurs. These at first are freely movable and without tendency to suppuration or degeneration. Later it extends to glands in other regions. The nodes become fused into irregular masses sometimes of large size and cause disfigurement. There is enlargement of the spleen, anemia, progressive anemia, and death.

Diagnosis.—Its diagnostic importance lies in the necessity for differentiation from other affections of the glands in the region of and surrounding the buccal cavity (see p. 428, and Figs. 254 and 255).

Prognosis.—Death usually results.

Treatment.—Treatment is unsatisfactory. Arsenic in early stages, removal of the individual glands, and the use of the *x*-rays. They are all recommended.

FIG. 291.—Face of young woman in whose case nearly all of the lower jaw was removed from the ramus on the left side to the molar region on the right for the removal of the myxoma shown in Fig. 292. Preservation of the periosteum which was permitted on account of the character of the growth and retention of the form of the jaw during healing process resulting in new bone formation so that the girl is now able to wear a lower set of teeth on the newly formed jaw and is only slightly shorter on the left side instead of having the great deformity that would otherwise have resulted.

Myxoma.—Myxoma is mucous tissue tumor.

Etiology.—The cause of myxoma are identical with those of fibroma, and combinations of the two render radical distinctions impossible.

FIG. 292.—Same girl shown in Fig. 291 before the removal of the myxoma, showing the extent of the jaw involved.

Symptoms.—It appears as a homogeneous structural gelatinous mass, grayish or reddish white in color, and composed of a gelatinoid or whitish mucilaginous material. When arising in submucous or cutaneous or subcutaneous tissues they may be pedunculated and in the form of a distinct polyp. A pure form of nasal myxoma occurs in polyps of the mucous membrane of the nasal passages and accessory sinuses. These polypi may be single or in clusters, and their effect

is to cause nasal obstruction which sometimes leads to diseased conditions of the associated sinuses or the pharynx.

Prognosis.—Under proper treatment this is favorable.

Treatment.—The treatment consists in removal and, if possible, correction of the predisposing condition, otherwise there is likelihood of recurrence.

In the case shown in Figs. 291 and 292 the myxoma was peeled out with the fingers from the angle of the jaw on the left side of the mouth to the middle of the body of the jaw on the opposite side. It was removed in large masses, almost intact.

MALIGNANT GROWTHS.

Sarcoma.—Sarcoma is an embryonic connective-tissue tumor in which the cellular constituents usually predominate over the intercellular substance.

Varieties.—Varieties of sarcoma placed for clinical purposes in the order of their malignancy are: (1) Giant cell. (2) Spindle cell. (*a*) Large spindle cell. (*b*) Small spindle cell. (3) Round cell. (4) Mixed cell. (5) Alveolar. (6) Melanotic.

Most sarcomas are mixed growths. The determination of malignancy depends upon the character of the cells that predominate in the growth, and it is usually described as of a type in accordance with the predominating cells.

Alveolar sarcoma is a rare form in which the cells assume an alveolar enlargement quite like carcinoma.

Giant-cell or myeloid sarcoma is a form resembling the red marrow of young growing bone.

Sarcomatous growths show marked tendency to secondary changes which sometimes result in the more or less complete development of connective-tissue structures. Thus we have *osteosarcoma* when true bone formation occurs, *chondroid* or *chondrosarcoma* when cartilage results, *myxosarcoma* with mucoid tissue, *endothelioma* (plexiform angiosarcoma), a highly vascular tumor due to preëxisting or newly formed vessels with cell-nest formed by proliferation of endothelial cells (Fig. 293). *Mixed tumors* of the parotid gland are quite commonly endotheliomas (Fig. 294). *Melanosarcoma* is distinguished by black pigment in cells and intercellular substance, and is generally recognized as the most malignant of all sarcomas (Fig. 295).

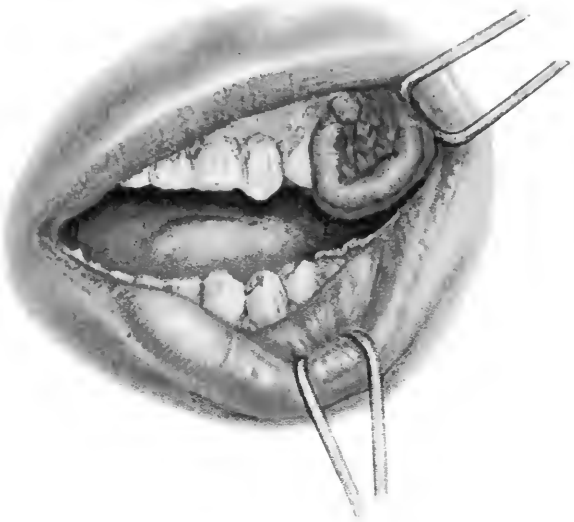
Sarcoma of the Jaw.—Epulis.—This term is applied to tumors which spring from the fibrous tissue of the gum and the periosteum, and which might be papilloma, fibroma, carcinoma, or sarcoma. It is, however, most commonly used to describe giant-cell sarcoma.

Etiology.—There is usually some local irritation which appears to excite the growth.

Symptoms.—The growth appears upon the gum (Plate XIII, Fig. 1), gives little disturbance outside of mechanical interference, spreads

PLATE XIII

FIG. 1



Epulis. (Grünwald.)

FIG. 2

Woman, Aged Seventy Years, with the Sarcoma from which the Sections Shown in Figs. 295, 296, and 297 were Cut.

history of this case showed that the trouble began in the maxillary sinus years before. After the first removal there was a period of two

FIG. 294.—Mixed tumor of the parotid. (Sultan-Küss.)

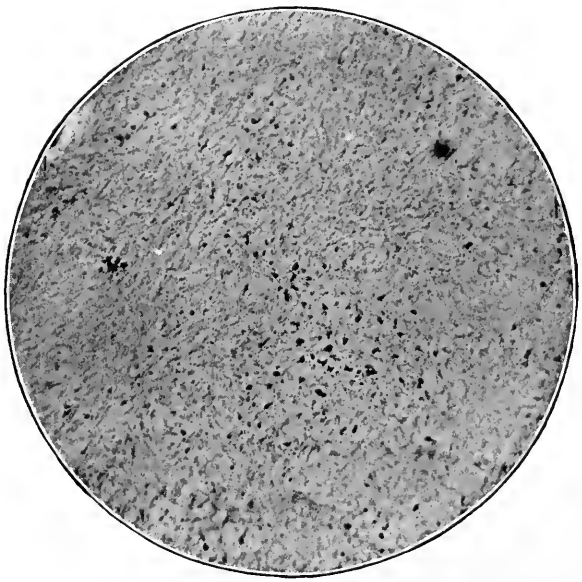


FIG. 295.—Section of melanosarcoma, showing pigmentation.

years without recurrence. The sections indicate very plainly the predominance of spindle cells in the older parts of the growth, mixed spindle and round cells in a later section, round cell, and finally melan-

otic sarcoma. Figs. 299 and 300 are sections of a growth illustrating one danger. It had been examined at a well-known laboratory and

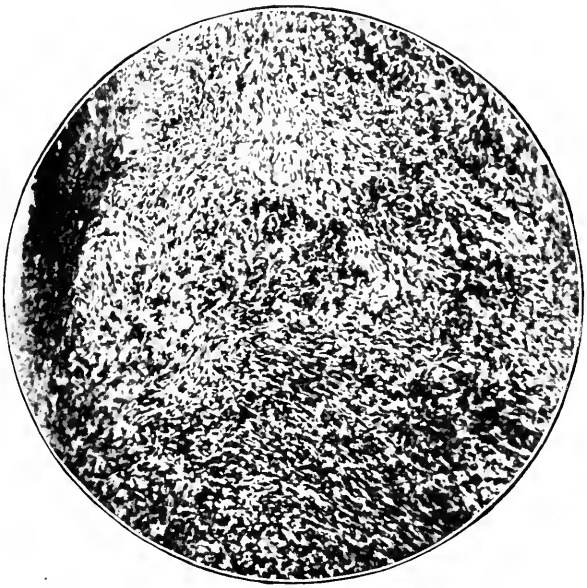


FIG. 296.—Spindle-cell sarcoma. A section from the growth shown in Fig. 294.

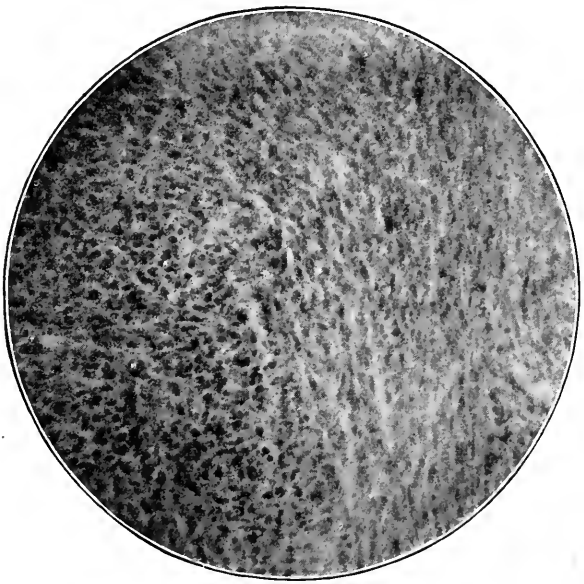


FIG. 297.—Round-cell sarcoma. A section of the growth shown in Fig. 294 cut from a portion of later development than Fig. 296.

reported as inflammatory tissue. When the patient came under the author's care a section was made which seemed to confirm the previous report, yet deeper sections made after removal of the deeper-seated portions of the growth show plainly the sarcomatous condition.

In another of the author's cases microscopic sections failed to disclose the malignant character of a tumor. Under these circumstances it was deemed unwise to make a wide resection of the jaw, and yet it was subsequently learned that this patient died within six months from sarcoma recurring in the same region. In dealing with malignant tumors of the jaw, both sarcomatous and carcinomatous, the decision as to the character of the operation is a grave

FIG. 298.—The pigmentation of melanosarcoma in a section from the same growth shown in Figs. 294, 296 and 297.

one. Undoubtedly many jaws have been resected and the future comfort of the lives of these individuals blasted when the growths were benign and there was no need of radical operation. On the other hand, to do an insufficient operation in the face of active malignancy is merely to add fuel to the flame and hasten the progress of malignant development (Fig. 301). Immediate diagnosis by the microscopic examination of a frozen section at the time of the operation, when this can be done, is by all means the best method of dealing with such growths.

Operation for Giant-cell Sarcoma.—The growth must be completely removed down to and including the periosteum, as well as the teeth that may be immediately adjacent to the growth. It is the author's

practice to remove one tooth upon each side beyond the growth and with a surgical or dental engine bur to remove the alveolar process down to and including the full extent of the tooth socket, so that by

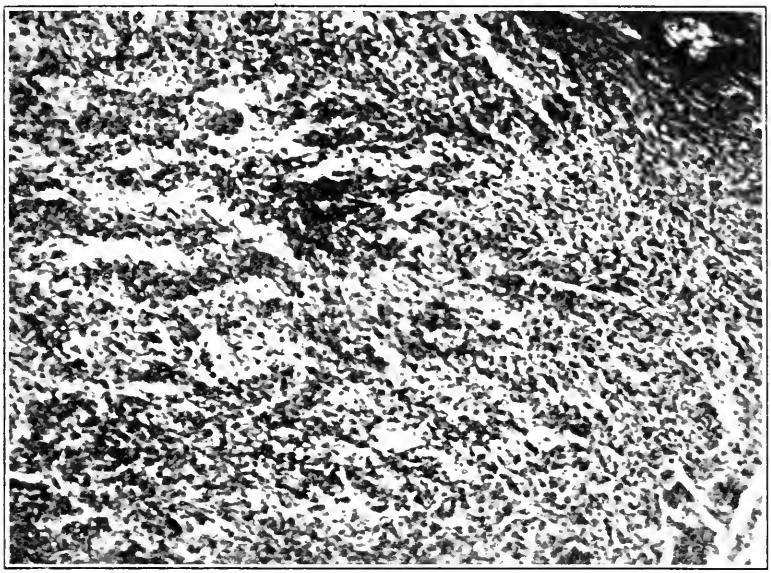


FIG. 299.—Section of a sarcoma of the lower jaw.

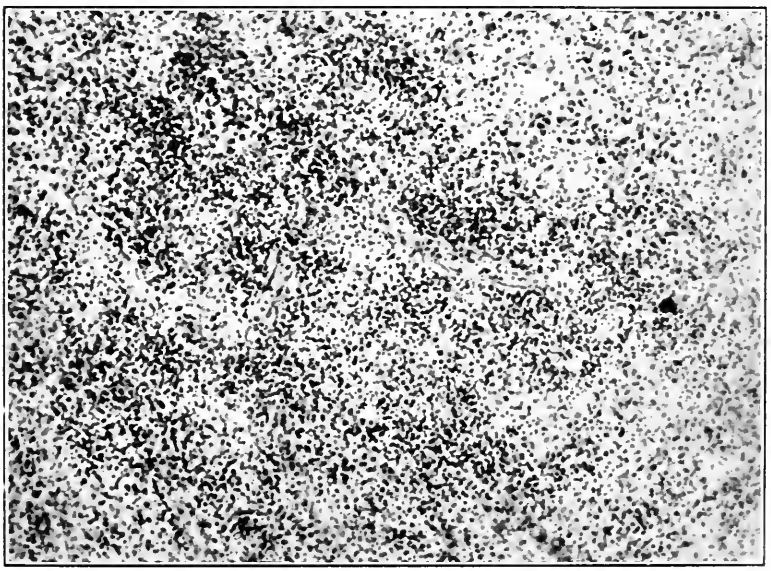


FIG. 300.—Section of a sarcoma of the lower jaw. Same case as Fig. 299.

no possibility might there be a portion of the pericementum allowed to remain.

The treatment of other more malignant forms of sarcoma is described with carcinoma under Treatment of Malignant Growths.

FIG. 301.—Sarcoma. (Westmoreland.)

CARCINOMA—CANCER.

Carcinoma is an embryonic or atypical neoplasm that always develops from epithelial cells.

Varieties.—(1) Epithelial carcinoma or epithelioma. (2) Glandular carcinoma.

1. **Epithelioma.**—There are three principal types of epithelioma—*squamous, cylindric-cell* and *tabulated.*

SQUAMOUS EPITHELIOMA.—This form grows upon cutaneous or mucous surfaces, and its epithelial elements are much like the squamous epithelium of skin and mucous membrane. Transverse sections show typical nesting of cells, called epithelial nests. When these harden, as by age and keratinization, they are termed pearls, and it is called a pearly epithelioma (Figs. 302 and 303).

Symptoms.—Squamous epitheliomas are usually found where skin and mucous membrane join or at the meeting-point of two kinds of epithelium. The situations which are of special interest to our subject are the lower lip, nose, tongue, gums, palate, tonsils and pharynx. The digestive, generative, and similar parts are also affected. The hands and feet rarely.

The first sign of its appearance is usually a small indurated nodule just under the epithelium. Later, an irregular ulcerated warty surface develops, from which occasionally there is a slight exudation denoting ulceration within a surrounding indurated border. This leads to incrustation. Beneath the scab, if removed or if it drops off without removal, the developing cancer is plainly seen.

Cylindric-cell Epithelioma (Adenoid Cancer, Columnar-cell Epithelioma, Malignant Adenoma).—In this variety there are

Fig. 302.—Squamous epithelioma of the cheek. (Section from case shown in Fig. 303.)

Fig. 303.—Man with carcinoma of the cheek and lower jaw. Fig. 302 shows a section of the growth. The scar of a previous ineffective operation may be noted.

tubular cavities in which layers of cylindric cells are separated by a stroma. The more nearly the appearance resembles true gland formation the slower the growth. When it is unlike gland tissue and

the cells are small and in irregular arrangement, rapid growth and recurrence may be looked for.

Symptoms.—They are more likely to be found in young patients than other forms of epithelioma, are soft and gelatinous and commonly appear upon the mucous membranes of the gastro-intestinal tract or the uterus. They also appear in the liver, kidney, and other organs, and may grow very slowly or with great rapidity.

Tubulated Epithelioma (Rodent Ulcer, Lupus Exedens, etc.).—This form of epithelioma has irregular pavement epithelium arranged in plugs or cylinders, embedded in a stroma of connective tissue. The epithelial nests and pearls are not found in these growths. Rodent ulcer affects old people, appears most frequently on the face, tongue, corner of the nose, and in similar situations upon skin surfaces. It usually grows very slowly, sometimes for years without attracting much notice, or it may progress rapidly from the beginning. The ulceration upon the surface is in most cases surrounded by an elevated, irregular, indurated border.

2. **Glandular Carcinoma.**—This form of carcinoma is a tumor springing from preëxisting gland tissue. The tendency of modern writers is to discourage the use of the term scirrhous or hard cancer and encephaloid or soft cancer, and other terms used to describe different degrees of consistency of the growth as distinct forms. The degenerative processes which lead to these structural alterations are themselves so variable and so intermingled that clinically at least they are not entitled to such positive and absolute distinction.

The use of the terms *colloid* or *gelatiniform carcinoma*, *mucoid*, and *melanotic*, or *pigmented sarcoma*, are also more properly recognized as different forms of degeneration and not wholly different types of growth.

Symptoms of Glandular Carcinoma.—Glandular carcinoma is found on mucous membrane surfaces, in the digestive tract, the mammary gland, pancreas, kidneys, ovaries, and similar situations. The tumors appear as nodular infiltrating growths of exceedingly variable consistency. Upon section the growth shows a glistening white color, has more or less translucency, and there is a lymph-like exudation, composed of albuminous fluid containing degenerative epithelium and oil-droplets, that appears on the surface.

General Considerations and Etiology.—With research laboratories throughout the civilized world actively engaged in the investigation of the cause and nature of cancer, and in the absence of positive and generally accepted findings, it is impossible to tell what complete changes in the present theoretical structures in this relation the near future may bring. In the meantime clinical features, more or less uniformly recognized by all surgeons, must receive due consideration in addition to the theories of cancer causation previously described with reference to tumors (pages 431 to 433).

Crile, in his oration on the cancer problem,[1] calls attention to the

[1] Med. Record, June 6, 1908.

fact "that although the cause of cancer still remains unknown, many of its phenomena have been carefully studied. It occurs in every climate and among all mankind, savage and civilized, in wild and in domestic animals, carnivorous and herbivorous, in birds, fishes, reptiles even in the lowly oyster. Throughout Nature the histological picture of any definite cancer is the same.

"Although the primary cause is not known, many of the predisposing causes and precancer states are known and can be recognized. The growth of carcinoma rarely follows a single trauma, but in the visible fields it is frequently preceded by chronic irritations, by scars and ulcers, by hyperplasia, by chronic inflammation, and by preexisting benign growths. Among the benign growths predisposing to cancer let us note fibromas, papillomas, adenomas, and cysts.

"Most innocent tumors of the parotid ultimately become sarcomatous. Many irritated moles freely metastasize as deadly melanomas."

Location.—Extract from summary of Crile's[1] operative cases. The total number was 132, of which the following were:

Location.	Operations.	Recoveries.	Deaths.
Carcinoma of face (including maxillæ)	15	14	1
Carcinoma of lips	31	31	0
Carcinoma of floor of mouth	4	1	3
Carcinoma of soft palate	1	1	0
Carcinoma of alveolar process	2	2	0
Carcinoma of tongue	12	10	2
Carcinoma of parotid	5	5	0

With regard to the "cancer areas" and "cancer houses" theories sometimes advanced by those who believe in the infectious character of cancer, Simon[2] reports five deaths in an old double farmhouse in Wales. The farmer's wife died of cancer in 1882; the daughter-in-law had cancer from 1886 to 1890, when death resulted; the daughter died of cancer in 1896; the woman who lived on the other side of the house, who nursed one of the women affected with cancer, herself died of the disease in 1900; and this woman's husband died of cancer in 1903. Five deaths in different families in the same house between 1882 and 1903.

The fact that epithelioma of both lip and tongue is much more frequent among men who are confirmed smokers and who have bad teeth is also significant, as is the fact that these growths grow in other situations of the mouth where diseased conditions of teeth and gums are prevalent. Park states that one-fifth of the cases of epithelioma of the tongue are preceded by leukoplakia. In other regions the well-known chimney-sweep's cancer of the scrotum and similar cancers that are known to occur frequently among those whose vocations expose certain surfaces to continued or unusual irritation all mark very plainly the significance of irritation in this regard. E. H. Bashford, in his report of the experimental study of the Imperial Cancer Research at the Medical Congress in Budapest, calls attention to the

[1] Jour. Am. Med. Assn., December 1, 1906, p. 1785.
[2] Practical Medicine Series, 1910, ii, 116.

fact that by suitable technic it is now possible to reproduce all the lesions of cancer experimentally—"local inflammation, systemic dissemination, and the terminal cachexia"—and concludes that "it is now agreed that infection plays no part in the experimental transference of cancer, which is a true transplantation of living cells."[1]

Age.—There is undoubtedly a predisposition, or at least a weakened resistance, to cancer in persons of advanced age, as evidenced by its frequent occurrence between the ages of forty-five and sixty-five years and its infrequency in early life.

Murphy's Laws.—Murphy has laid down the following laws:[2]

"Law 1. Repeated mild traumas and irritations, particularly at the border-line of different epithelial fields and cicatricial tissue, are potent etiological factors in carcinoma.

"Law 2. Moderately severe traumas once applied never produce carcinoma.

"Law 3. Moderately severe traumas—not to a degree of laceration or fracture—are frequently the cause of sarcoma and the precipitation of tuberculosis.

"Law 4. Severe traumas to the degree of laceration or fracture never cause carcinoma, sarcoma, or focalized tuberculosis.

"Law 5. Sudden changes in conformation and vascularity, as embryonal defects, pigmented moles, warts, papillomas or cutaneous fibromas usually indicate beginning malignancy and always demand immediate removal."

Symptoms.—The appearance of the different forms of cancer has already been briefly described, and is shown in Plates XIV, XV and Figs. 304 and 305. A general description of the clinical picture of the patients suffering from this affection, however, seems to be required.

Whether progressing by destructive ulcerative process or as a tumor mass involving the surrounding structures, there is always marked tendency to lymphatic infection, and the lymph nodes thus affected really are in the nature of metastatic extensions which partake of a full measure of malignancy.

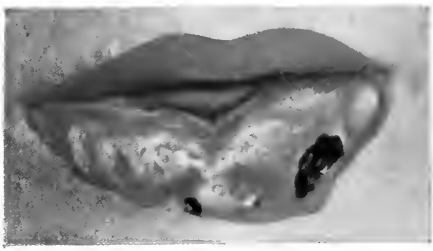
Epithelioma or carcinoma springing from any of the structures of the mouth, such as the lip, jaw, gland, or tongue, may by extension involve or include any or all of the other tissues. There is usually little if any pain until certain nerve fibers or branches of nerves become affected or secondary inflammatory processes create more active disturbance. Both pain and tendency to severe hemorrhage must be expected as the disease extends to the large vessels as well as nerves. In some cases the general health and appearance seems to be unimpaired for some time, but as the growth progresses the characteristic cachexia appears. This is the result either of a poisonous toxin incident to the growth itself, or of septicemic conditions derived from degenerative processes within or associated with the tumor. The growth causes a foul odor, and an unpleasant flow of saliva dribbles

[1] Lancet, September 4, 1909.
[2] Practical Medicine Series, 1909, ii, 96.

PLATE XIV

FIG. 1

FIG. 2



Epithelioma of the Lower Lip.

FIG. 3

FIG. 4

Epithelioma of the Lower Lip, with Lips Closed and Lower Lip Everted.

PLATE XV

Carcinoma of the Tongue.

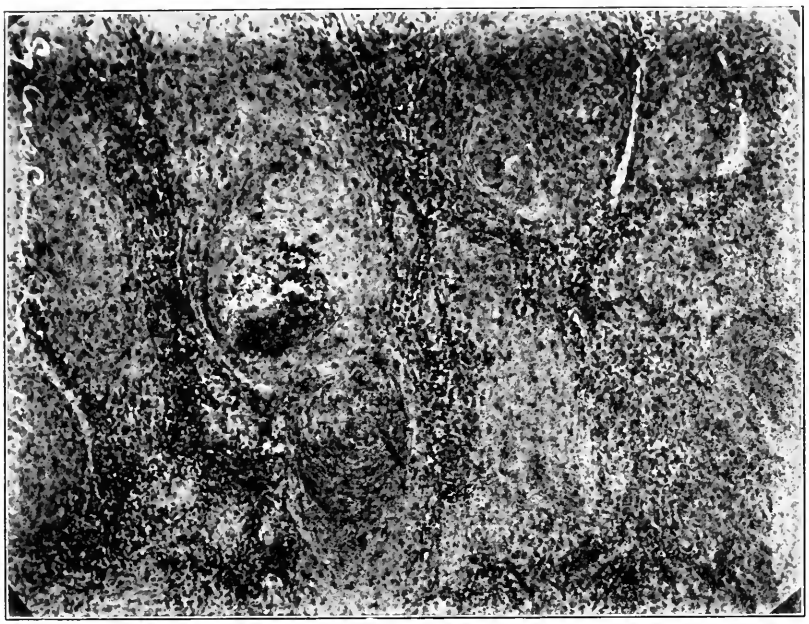


Fig. 304.—Section of epithelioma of the lower lip from case illustrated in Fig. 301.

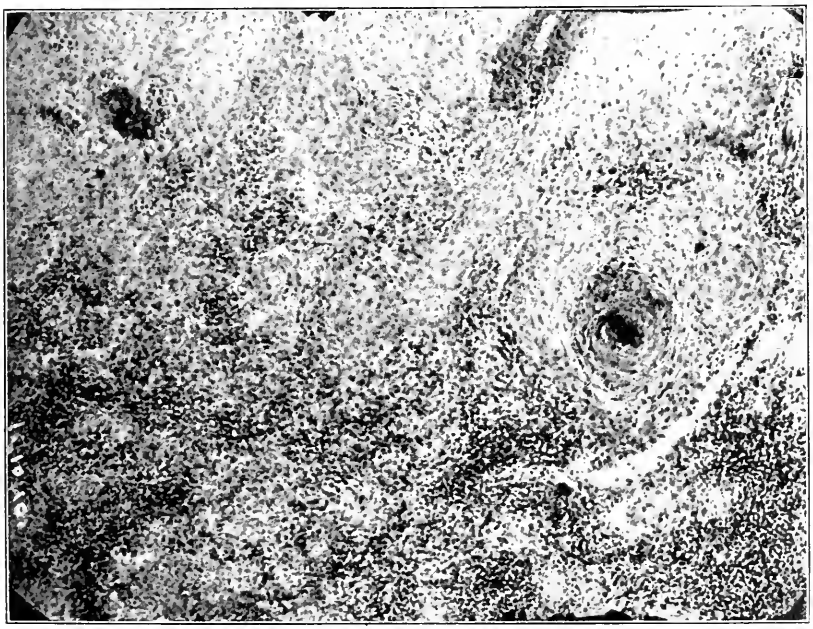


Fig. 305.—Section of epithelioma of the lower lip from case illustrated in Figs. 301 and 304.

from the mouth as the usefulness of the parts is lost, which, with the discouragement of such individuals, makes the general picture exceedingly distressing. Death usually results from the invasion of some vital part, from malnutrition, or from infection.

Diagnosis.—There are no symptoms of cancer which distinguish them completely and absolutely from the pathognomonic indications of other affections. Except in cases in which the growths are superficial and of such form as to be recognized by their clinical indications, microscopic sections give the only definite means of diagnosis. The first and most important question is whether the growth is benign or malignant (page 435).

The differentiation between sarcoma and carcinoma must then be made. These Coplin has exhaustively outlined as follows:

DIAGNOSTIC FEATURES OF SARCOMA AND CARCINOMA.[1]

	Sarcoma.	Carcinoma.
1. Origin.	Entirely mesoblastic (connective-tissue type).	Epiblastic and hypoblastic (epithelial tissue type).
2. Stroma.	Intercellular. Rarely forms alveoli.	Vascular connective tissue which surrounds and forms the walls of the alveoli; these communicate with one another and contain masses of epithelial cells.
3. Cell.	Granulation tissue or embryonic connective-tissue cells; shape and size vary.	Epithelial cells contained within alveoli; shape and size vary. Absent, or merely fluid.
4. Intercellular substance.	May be present	Absent, or merely fluid.
5. Vessels.	Embryonic in character. They are in direct contact with, or may be formed by, the special cells, slightly modified, of which the tumor is composed.	Well developed; entirely contained within the connective-tissue stroma, and supported by the walls of alveoli. Seldom in contact with the cells.
6. Spreads.	Primarily and secondarily by bloodvessels, rarely by the lymphatics.	Primarily by lymphatics, except in later stages, when it may also spread by bloodvessels, in which case it spreads with very great rapidity. Secondarily by bloodvessels.
7. Secondary changes.	Chondroid, osseous, calcific; pigmentary changes frequent.	Very rare.
8. Growth.	Not invariably continuous. Likely to be interrupted.	Rapid, continuous.
9. Site.	Primarily in deep structures; always from connective tissue.	Never encapsulated.
10. Heredity.	Seldom hereditary.	May be hereditary.
11. Capsule.	Primarily, pseudo-encapsulated; later infiltrates the surrounding tissue.	Never encapsulated.
12. Fat.	Rarely, if ever, contains fat.	Nearly always contains fat.
13. Age.	Occurs most frequently before middle life.	Most frequent after middle life.
14. Injury.	Not uncommonly follows injury such as trauma.	Rarely, a history of trauma, but may follow prolonged irritation. Especially is this true of the superficial forms.

[1] Coplin: Manual of Pathology, p. 363 (after Woodhead, modified and extended).

In many cases malignancy can be diagnosticated almost at a glance, but in doubtful cases in which prompt and effective treatment might produce good results the difficulties are sometimes trying.

When the operation is performed in a properly equipped and ordered hospital and section of the tissue can be made immediately, frozen, studied under the microscope, and reported before the patient has come out of anesthesia, these difficulties are, of course, avoided.

In other cases the alternative lies between operation without full knowledge, with the attendant risk of doing too much or too little, and the danger of aggravation by a previous even though small cutting from the growth for the purpose of microscopic study, with an interval of perhaps a number of days before performance of the complete operation. How much or how little actual risk of converting operable into inoperable cases occurs in this practice is impossible to determine exactly.

Ryall[1] sums up this danger in the following positive manner:

"In the parent growth the cells are more or less encapsulated in fibrous tissue, but some cells escape during operation and find a resting place in the wound, which is comparatively unprepared to meet and resist the invasion.

"Cancer cells may escape during operation as the result of incising or lacerating the primary growth, cutting across or tearing an infected lymph vessel, or even from rupture of a cancerous gland, and such cells are quite capable of causing and do frequently cause cancer recurrence.

"In cases of doubtful malignancy, where Nature's barriers are intact, do not remove a section for examination—remove the tumor and make the microscopic study afterward."

Differentiation between some of the infectious diseases, notably tuberculosis, may be confusing, as the two are sometimes associated.

The special characteristics of infectious diseases usually make diagnosis clear, especially in the field of the mouth and jaws, where direct examination is possible. Hemolysis has been extensively tested to determine the possibility of a positive or negative reaction with regard to blood serum and cancer cells. The reports of Blumberg,[2] Johnson, Canning,[3] Smithy,[4] Arnold,[5] the experiments of others, the results of which have come to the author personally, and in a limited way tests upon his own cases show that this method cannot be depended upon for diagnosis in the present state of our knowledge. The antitryptic index or the power of inhibiting tryptic digestion possessed by a serum as compared with that of a normal standard serum has been investigated by Bayly. He reports 30 cases, 26 of

[1] Practical Medicine Series, volume of General Surgery, ii, 121.
[2] Med. Record, January 9, 1909.
[3] Jour. Am. Med. Assn., October 30, 1909.
[4] Ibid.
[5] Yale Med. Jour., November, 1909, p. 143.

which showed markedly raised index, 3 normal index, and 1 subnormal index, a result evidently too uncertain for practical use.[1]

Prognosis.—Prognosis in cancer of the lips, floor of the mouth, tongue, and jaws is grave to the point of hopelessness. Its future aspect is more hopeful than records of the past would indicate, and earlier diagnosis and prompt extensive operation with radical block dissection of the neck promises much. Crile[2] calls attention to the fact "that among 48 traced cases operated upon more than three years ago, in which radical block section was not made, 9 are living; and in 12 cases in which block section was performed more than three years ago, 9 are living." His conclusions in this respect are important. "The head and neck present an exposed field. Cancer here, unlike that of the stomach, intestines, or even the breast, may be recognized at its very beginning; in every case it is sometimes curable by complete excision. That the field of regional metastasis is exceptionally accessible, but cancer rarely penetrates the extraordinary lymphatic collar of the neck. As the growth tends to remain here localized, application of the same comprehensive block dissection, as in the radical cure of breast cancer and free utilization of the modern researches of surgery, renders the final outcome in cases of cancer of the neck and head more promising than that of almost any other part of the body."

Warren[3] reports 122 operations for cancer of the tongue and floor of the mouth; 16 (14.2 per cent.) remained free from recurrence over three years. Butlin reports 197 cases of cancer of the tongue; 20 died following the operation; 22 were operated upon recently; in 55 there was no recurrence for periods averaging from thirty to thirty-three years.

Dollinger reports 6 cures in 58 cases.

According to Warren the mortality varies with the extent of the operation; its lowest (5 per cent.) with the intrabuccal operation, and its highest (30 to 35 per cent.) in the operations involving division of the lower jaw.

"A careful study of 4500 cases, exclusive of the thyroid gland, traced to their original report in literature, made for me by Dr. Hitchings, showed that in less than 1 per cent. have secondary cancer foci been found in distant organs and tissues."[4]

Treatment of Malignant Growths.—Whenever possible the treatment of cancer should be begun in the *precancerous stage,* that is, whenever there are indications which by any possibility might lead to malignancy. These should be completely and thoroughly corrected.

Among the many methods of treatment that have from time to time been tried, the following have received more or less serious attention.

[1] British Med. Jour., October 23, 1909.
[2] Jour. Am. Med. Assn., December 1, 1906, p. 1780.
[3] Ann. Surg., 1908, xlviii.
[4] George W. Crile: Jour. Am. Med. Assn., December 1, 1906, p. 1780.

Injections of *mixed toxin of erysipelas* and *Bacillus prodigiosus* in the treatment of sarcoma are reported by Dr. William B. Coley[1] to have checked the growth in a considerable number of cases and to have effected more or less permanent cures in at least a few instances. The number of these, however, is hardly sufficient to warrant dependence except when operation is contra-indicated.

Enzyme treatment as recommended by Beard, injectio trypsini and injectio amylopsini respectively, designed to kill and digest the cancer cells, and pancreas gland extract containing trypsin, amylopsin, and lipase with the milk-curdling ferment, after careful tests by Bainbridge,[2] have failed to check cancerous progress.

Frederick Gwyer[3] uses the *dried thymus gland* of the calf, and reports improvement as a result of continued administration, sometimes in doses as large as an ounce of the powder.

Park recommends the use of *thyroid extract*, 5-grain doses three or four times a day, simultaneously with the use of the *x*-rays, claiming that the latter enhance the efficiency of the thyroid treatment.

Radium.—The complexity of governing conditions in determining the action of radium such as variation in the dosage and methods of application by different operators, differences in filters, and in the effects of alpha, beta, gamma and secondary rays, have led to much confusion in the reports of the results of radium therapy. There have been remarkable cures by its use, and also many disastrous failures. The following recommendations by Doppert, reported by Ewing[4] seem to be along conservative lines (1) for early localized cases—radium; (2) established, or border-line cases—operation; (3) inoperable cases—radium; (4) advanced cases—neither radium nor operation.

Cancers of the mouth, tongue, tonsil and pharynx, present uncertainties for radium treatment both because of anatomical difficulties and great differences in the character of carcinomatous growths in these regions. Much progress is being made in the direction of overcoming these disadvantages by skilful and intelligently applied treatment. Radium intoxication is a term applied to the phenomena sometimes following long exposure to large amounts of radium. The patients suffer from nausea and vomiting, extreme muscular weakness, feeble pulse, and diminished urine. Ewing in calling attention to this states that "radium in any but experienced hands, is a dangerous agent," but "precautions should not be permitted to stand in the way of the normal legitimate extension of the radium treatment of cancer."

"In the 'field' of precancerous lesions, hypertrophies, atypical inflammatory overgrowths, warts, and polyps of mucocutaneous junctions, numerous leukoplakias, cervical erosions, nevi, and many

[1] Ann. Surg., December, 1908, xl, 465.
[2] Scientific Report New York Skin and Cancer Hospital, 1909.
[3] Ann. Surg., xlvii, 506.
[4] Jour. Am. Med. Assn., April 28, 1917.

accessible benign tumors, radium is both efficient and comparatively free from danger."

Injections into the growth of *soap*, *potassium*, and *sodium* and the *internal administration of many drugs* have all in course of time been tried and found wanting. The use of *plasters* and *pastes of arsenic* destroy the surface in superficial growths upon which such paste can be safely applied, and have sometimes proved beneficial. The serious tissue destruction from the use of the arsenic, which after all does no more than other less advantageous agents, is, however, objectionable.

Liquid air has been used to freeze and destroy such tumors. In favorable cases it has caused the scab to slough away with sufficient tissue to cause cicatrization of the underlying tissues without recurrence.

The *actinic rays of the sun* were utilized in one case of which the author has personal knowledge. It was a rodent ulcer at the angle of the nose which had been removed by slight operations four or five times with repeated recurrence. The patient, a man, aged about seventy years, spent many hours each day with the sun's rays focussed upon the ulcer with a magnifying glass, allowing it to burn as long as he could support it; after waiting a few moments for relief, he would burn it again. In the course of a few months the scab came away, leaving the skin surface smooth and clean beneath, better than it ever appeared after removal by operation, and for a longer time without recurrence, although it did recur.

Ultraviolet or "*Finsen light*" has proved beneficial in some cases, but the number is too limited for it to be considered a valuable method of treatment.

X-ray treatment is by far the best agent exclusive of the knife. Unscientific use of the Roentgen rays through undertaking to do the impossible, and ignorance of its character, the dosage, and other matters which are now thoroughly understood by those competent to undertake this kind of treatment, at first caused much disappointment. It seems clearly established that upon skin surfaces where the growth can be directly reached by the rays, their curative powers are remarkable. Rodent ulcers, epithelioma of the lip at a sufficiently early stage, and cancerous growths in other similar situations can be effectively controlled. As both the skin and mucous membrane act to some extent in the nature of insulators, the *x*-rays do not always effectively penetrate the deap-seated growths or deeper portions of the growth. Used in after-treatment directly upon the tissues after operation, as described in connection with the author's cases (page 492), *x*-rays are highly beneficial and should be a routine measure in almost every case.

The Percy method of the long-continued application of a degree of heat, low enough not to destroy, to any considerable extent, normal tissue cells, but of sufficiently high temperature to cause, as has been shown that it will, the destruction of cancer cells, has opened a wide

field of useful treatment, especially in inaccessible situations. This is particularly true of the treatment of neoplasms in the region of the mouth and jaws. Percy's equipment for this purpose is very complete, and is now quite generally used.

Burning, to destroy the cancer and surrounding tissue, is a valuable method when it can be thoroughly applied.

FIG. 306.—Water-cooled retractor in place; wooden spatula protecting tongue preparatory to cauterization of epithelium, alveolar margin and cheek, as used by Dr. Gordon B. New.

Extirpation.—The one hopeful remedy at the present time lies in complete and thorough excision of the growth, and "block" operation upon the lymphatic channels by which the part is drained.

Operative Treatment.—The varieties of operation for removal of malignant growth of the lips, tongue, floor of the mouth, cheek and jaws may, in a general way, be divided as follows: (1) Intrabuccal. (2) Inframaxillary. (3) Division of the mandible. (4) Resection of the jaws.

Cancer of the Lip.—In removal of all forms of cancer, care should be taken not to allow the *knife to touch the cancerous tissue.* A wide excision should be made, if possible. There should be at least one inch

of tissue beyond the line of demarcation of the growth. The author's method of closure after extensive excision of cancer of the lower lip is shown in Figs. 307, 308 and 309. By carrying the skin and fascia

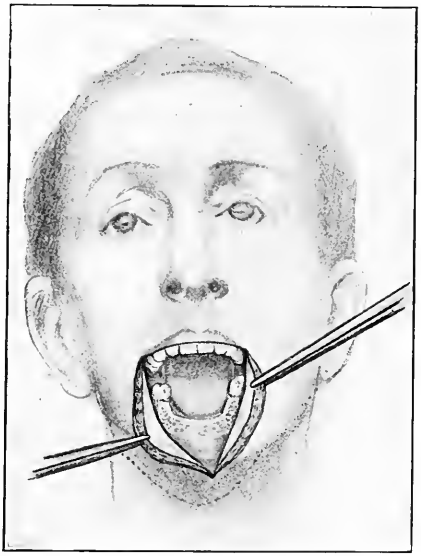


FIG. 307.—Method of closure of wound after extensive removal of tissue from the anterior part of lower jaw and lower lip. The parts are dissected free down to the dotted line.

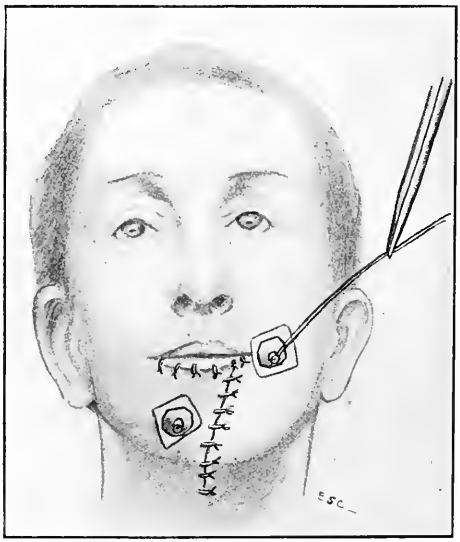


FIG. 308.—The parts closed and the labial border restored by suturing skin and mucous membrane.

from beneath the jaw, where there is always an abundance gives the least possible deformity. After removal of a considerable portion of the prolabium very satisfactory plastic repair can be obtained by suturing the mucous membrane to the skin border along the outline of the mouth as reproduced by the newly placed tissue. When this is not done, an unsightly and unyielding cicatricial border results, but with the mucous membrane carefully carried over and neatly sutured, a very fair reproduction of the original vermilion border can be secured. In all these cases, even though the cancer upon the lip be small, the lymphatics in the submental region upon the affected side must be removed. In advanced cases there should be Crile's block section, including the removal of the glands in both upper and lower triangles of the neck: when the growth is close to the median line this should be done upon both sides (Figs. 310 and 311).

FIG. 309.—Result of operation on lower jaw and lip performed as shown in Figs. 307 and 308.

This dissection of the avenues of lymphatic drainage is required in all forms of cancer of the lips, tongue, floor of the mouth, cheeks, and maxillæ. It is best performed in two stages with the mouth operation first and removal of the glands as soon after as the patient has sufficiently recovered to bear the operation. (Some operators reverse this order of procedure, claiming that the removal of the glands first reduces the danger of mestastatic extension.) The danger of shock and infection are both reduced in this way, and the records show a correspondingly marked decrease of mortality. Butlin's mortality in 13 cases was 23 per cent., as opposed to 7 per cent. mortality when the operation was performed in two stages.

Crile reports only one fatality in his last 72 major operations in this field as a result of better protection of patients from chilling, the employment of skilled anesthetists, and other means to prevent and overcome shock and decrease the number of infections and pneumonia.

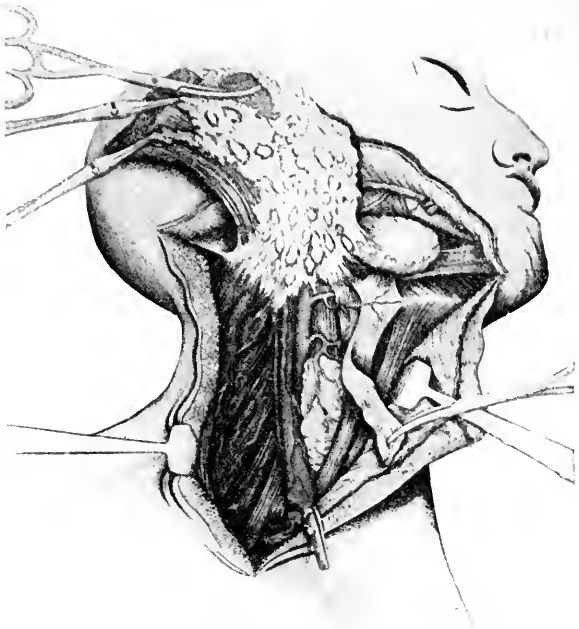


FIG. 310.—Block section for the removal of glands in both upper and lower triangles of the neck. (After Crile.)

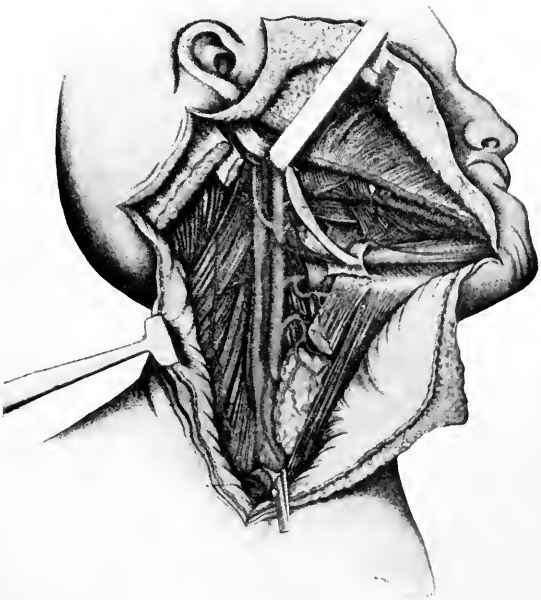


FIG. 311.—Block section for removal of glands in both upper and lower triangles of the neck. (After Crile.)

PLATE XVI

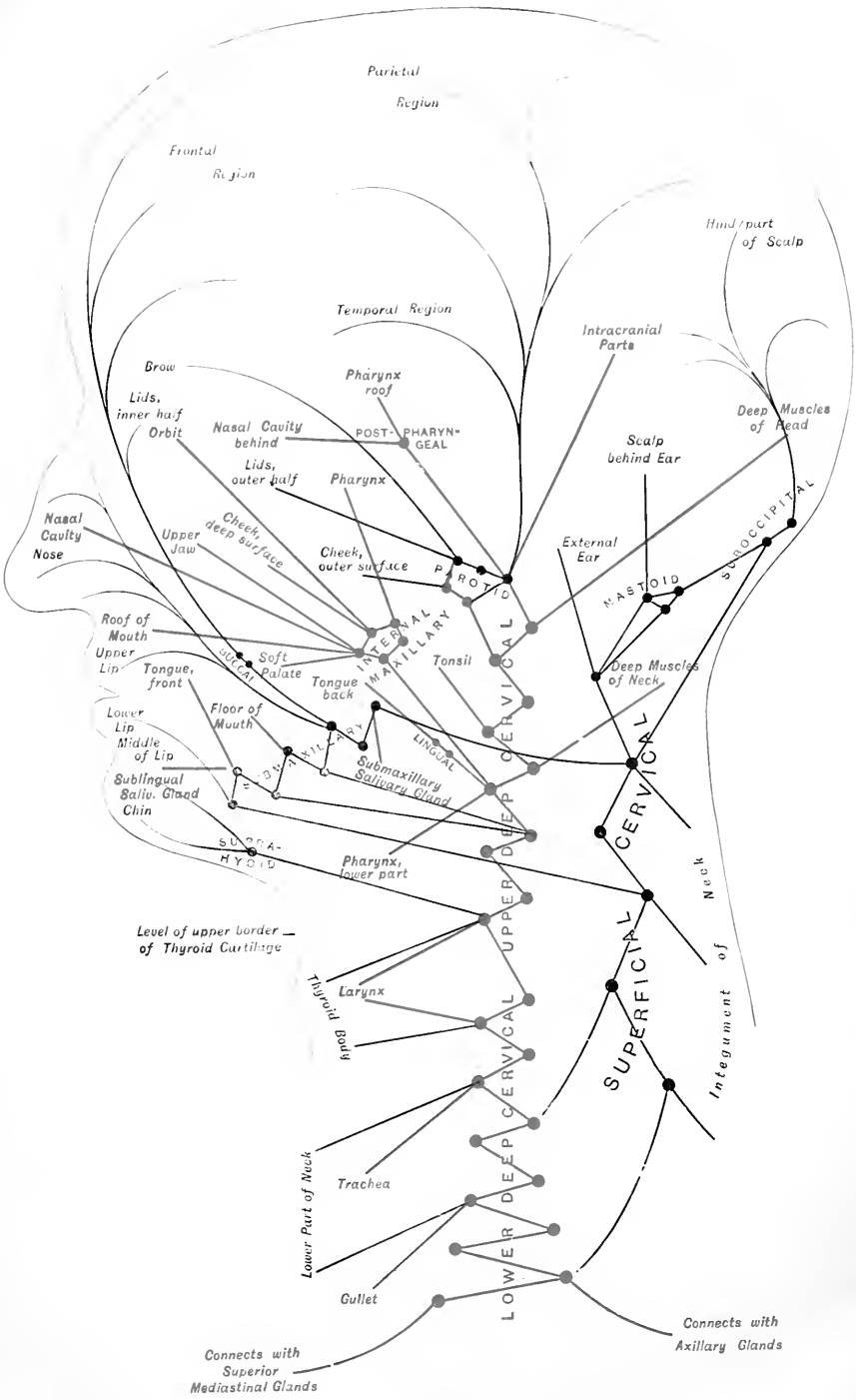
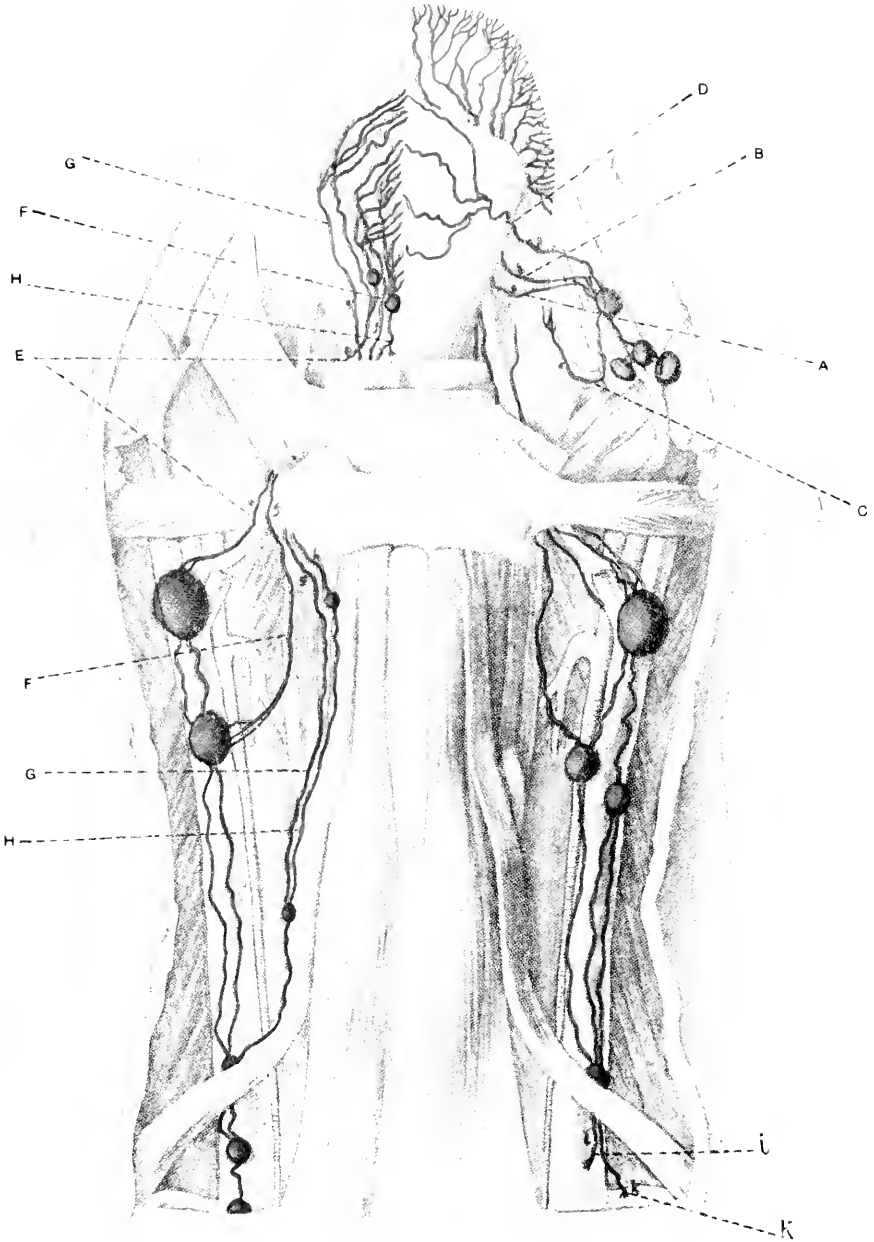


Diagram of the Nodes and Vessels of the Head and Neck, showing the Regions that are Drained into Each Group of Nodes. (Gerrish.)

Deep structures in red, superficial in black.



Anterior View of Lymphatics of the Tongue. (von Bergmann.)

The anterior portions of the digastric and the geniohyoid muscles have been removed. A large window has been cut in the mylohyoid and the genioglossi muscles pulled apart. On the right side the lymphatic vessels which empty into the deep cervical glands and pass between the genioglossi are shown (*G*, *F*, *H*, *E*). On the left side the lymphatics of the tongue which empty into the submaxillary glands (*A*, *B*, *C*) are shown above. Below at *I*, *K* are seen the terminal lymph vessels of the deep cervical glands emptying into the large venous trunks.

Cancer of the Tongue.—*Whitehead's Operation for Removal of the Tongue.*—For unilateral resections, the frenum and mucous membrane on one side of the tongue are divided. The dorsum of the tongue is incised through the median line and split along the raphé. Tension is then made by drawing the divided portion upward and forward until the geniohyoglossus muscle is stretched to its fullest extent. This is divided close to its point of origin; the tongue may then be drawn so far out of the mouth as to make it easily accessible for operation. When the entire tongue is to be removed, or on both sides of the anterior portion, the tissues are freed by making the same incisions upon both sides.

The lymphatic systems of the mouth and neck are shown in Plates XVI and XVII. It is important to note that the base of the tongue is practically separate from the body of the organ, and that its lymphatic vessels empty through the system in connection with the

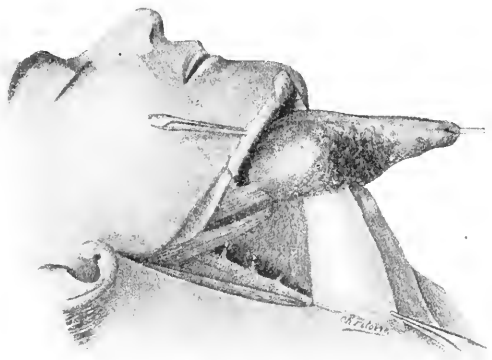


FIG. 312.—Inframaxillary removal of the tongue. (Kocher.)

submaxillary glands, whereas the lymphatics of the anterior part of the tongue find their avenues of connection through the cervical glands. This makes it possible to spare the posterior portion of the tongue in operation for the cancer, and as lymphatic anastomosis across the median raphé occurs imperfectly if at all in the early stages, at least cancer is usually limited to one side or the other of the median raphé. The lymphatics of the floor of the mouth and of the submaxillary lymphatic glands are in intimate relation and following in order. The superficial and deep cervical glands complete the chain.

Inframaxillary Operations.—*Kocher's Operation.*—A curved incision is made from the chin to the ear, with its lowest point close to the hyoid bone. The mouth is entered below the jaw by division of the mylohyoid muscle after dissecting free the submaxillary gland. The tongue and floor of the mouth are removed below the jaw, together with the lymphatics in the submental region (Fig. 312).

Temporary resection of the jaws for this purpose is described on page 384.

Warren reports 45 cases of cancer of the tongue with seven cures at the end of five years or longer (15.5 per cent.).

Cancer of the Lower Jaw.—Operation for cancer of the mucous membrane and alveolar process of the lower jaw, involving the bone, show a high mortality.

Warren[1] reports 40 operations upon these cases at the Massachusetts General Hospital, 10 deaths as a result of the operation (35.7 per cent.), and of these, within a five-year limit, there were but three cures. (See Resection of Lower Jaw, page 384.)

The operations performed upon these 40 cases were as follows:

	Cured.	Operative deaths.
Resection alone, 12	1	5
Resection, neck dissection, 4	1	2
Resection, neck, other parts, 3	1	1
Minor operations, 7	2	2

Cancer of Upper Jaw.—See Resection, page 393.

Cancer of the Cheek.—The incisions for cancer of the cheek cannot follow any definite rules, but must be governed by the form and extent of the growth. After the growth is completely removed, the open surface of the wound may be closed by plastic operation at a later operation if necessary. In these cases the *x*-rays can be advantageously applied directly to the unclosed wound surface.

Cancer of the Palate.—Resection of the jaw as described (page 384) may be required to expose the palatal region completely.

Cancer in the Region of the Maxillary Sinus.—In the author's opinion this can best be treated by A. J. Ochsner's method, which he has been kind enough to describe in a special letter as follows:

"We simply cut away with a chisel all of the diseased tissue that we can find and then cauterize the surface furiously with an ordinary soldering iron, which is heated to red heat, until every particle of diseased tissue as far as one dares to burn has been destroyed. Then we pack the cavity with the following solution: 20 grains of bicarbonate of soda, ½ ounce of salicylic acid, 3½ ounces of chloride of zinc, and enough commercial alcohol to make half a pint. A little of this is placed in a small glass and a piece of gauze saturated in the solution, but not sufficiently to cause it to drip. This is packed into the cavity and over it a dry piece of gauze is packed to take up all of the moisture which may escape. This packing is removed on the second or third day, and from that time on the cavity is packed with formalin gauze and is kept clean by irrigation."

The case, a man, aged fifty-four years, was referred to the author with an opening through the buccal wall of the maxillary sinus, with slight evidence of ulceration of soft tissues at the borders. The usual treatment by previous ineffective irrigation through the mouth and

[1] Am. Surg., 1908, xlviii, 503.

nose had been tried for some time previously. As there was no clinical evidence of malignancy at this time, a radical operation for empyema of the maxillary sinus was performed. The tissue healed quickly and the patient made an uninterrupted recovery. As a matter of precaution an elliptical section was taken, including the tissue all around the opening into the sinus before enlargement was performed in course of the operation. Sections from this under the microscope looked suspicious. Some six months later the growth reappeared in this region and this time was plainly shown to be carcinoma. There appeared to be two alternatives in treatment: one, a complete resection of the superior maxilla, with its almost certain deformity, the other, Ochsner's burning method, which would leave practically no deformity. The patient was referred to Dr. Ochsner, who operated by using a series (approximately 20) of red-hot soldering irons, with which he burnt the tissue in all directions. This was done from within the mouth without an external incision. Dr. Ochsner's claim that as much tissue could be removed without deformity by actual burning as would be taken out by resection, with its greater deformity and more risk, and that, in addition to this, sloughing of the burn would continue as the area of tissue destroyed would be increased by sloughing and bone exfoliation far beyond the actual outline of the first wound, thus antagonizing the formation of new cancer cells, was fully borne out by the result. A packing of muliptol was inserted and changed daily, bringing away from time to time masses of exfoliated bone and sloughing soft tissue. A second burning was necessary after several months because of recurrence, but since that time, a matter of four years, the patient has been quite free from growth of this region, and he has suffered neither deformity of the external face nor serious inconvenience through the loss of teeth and alveolar process which has been supplied by a dental plate. In the author's opinion this growth could not have been checked as well by any other method.

This method of deep burning has undoubtedly a wide field of application in dealing with malignant growths of the jaws in other situations as well as the maxillary sinus, but this particular case has been chosen for illustration because of the well-known difficulties encountered in complete extirpation of rapidly growing cancer in this region. A later report of this case, approximately nine years after treatment, shows that there have been no recurrence of the grouth. Without treatment he could hardly have lived six months.

Practical Results of the Use of the X-rays after Operation.—Cancer of the lip, as has already been stated, requires, in addition to the side removal of the affected lip tissue, removal of the lymphatic glands under the jaw. In most cases it is safer to remove the glands of the neck upon the affected side also. When genuine evidence of malignancy is present in any of these glands, it is safer not to close the skin surface immediately, but by opening the flap to enable the *x*-rays to be used directly upon the recently exposed surface.

It is well known that both skin and mucous membrane resists the penetration of the rays. Upon actual skin surfaces or upon directly exposed tissue, however, *x*-rays destroy malignant tendency.

One of the author's patients, a man, aged fifty-two years, gave a history of the formation of an ulcer at the border of his lower lip. It had continued despite the application of salves for a period of about ten years, when an operation was performed by the usual elliptical excision of lip tissue. As might have been expected, this was practically a failure and caused greater deformity than would have resulted from a more extensive properly performed operation. One cervical gland on the affected side had also been operated upon for an abscess, but no record of its nature was available. Upon examination the author found cancer affecting the lower lip and the gum tissue adjoining the lower incisor teeth. There were no enlarged glands apparent, either in the submaxillary or cervical region. The tongue was not affected. Operation was performed by wide removal of tissue, including the lower lip to and beyond the median line down to the chin, as shown in Fig. 307. The teeth, alveolar structures, and the anterior plate of the lower jaw, including the overlying tissues, were removed with a surgical engine bur, including also the cancellous structure of the bone. The compact bony structure of the inner surface of the jaw was left with a clean, smooth, hard surface. Over this the external wound was closed according to the author's method, as shown in Fig. 308. Prompt healing followed. The parts seemed to be entirely free from the old affection, and bridge-work was inserted by Dr. Percy B. Wright, of Milwaukee, which was attached to the remaining bicuspid teeth. It was composed of vulcanized rubber, which would permit of adjustment from time to time as the form of underlying tissues changed. For the sake of cleanliness and convenience this was made removable, and the gold crowns which held it in place were made to slip over other crowns which had previously been cemented to the bicuspids. The result is shown in Fig. 309. Instruction was given to have the cervical glands removed at an early day. At a subsequent operation some time later (six months) the submaxillary and cervical glands were removed by Dr. John L. Yates, of Milwaukee, and it was found then that cancer was evident as far as the clavicle, because the patient did not have an early operation as directed. Treatment with the *x*-rays by Dr. Otto K. Foerster and Dr. Baer, of Milwaukee, during a period of several weeks, with the skin edges ununited and turned back, resulted in shrinkage of tissue until not the faintest semblance of malignancy remained anywhere. About this time recurrence of the growth upon the site of the author's first operation upon the lower lip became evident. This was opened, a wide excision performed, and allowed to remain exposed to the *x*-rays, which were used triweekly with varied dosage. For a considerable time the use of the *x*-rays in this manner seemed to be completely effective, but recurrence and death ultimately occured. The dire results of neglecting ulcers on skin surfaces that

show tendency to become chronic, whether there be evidence of unmistakable malignancy or not, and the futility of ineffective operations according to old methods of excising a small portion of the lip and allowing the lymphatic glands to remain untouched, is very strikingly brought to notice. It is almost invariably advisable to operate upon the lip and mouth, and to perform a "block" dissection of the lymphatics, as recommended by Crile, as soon as the patient has sufficiently recovered to make operation upon the neck safe. Operation for resetion of the jaws is described on pages 384, 385 and 389 in connection with operations upon the maxillæ.

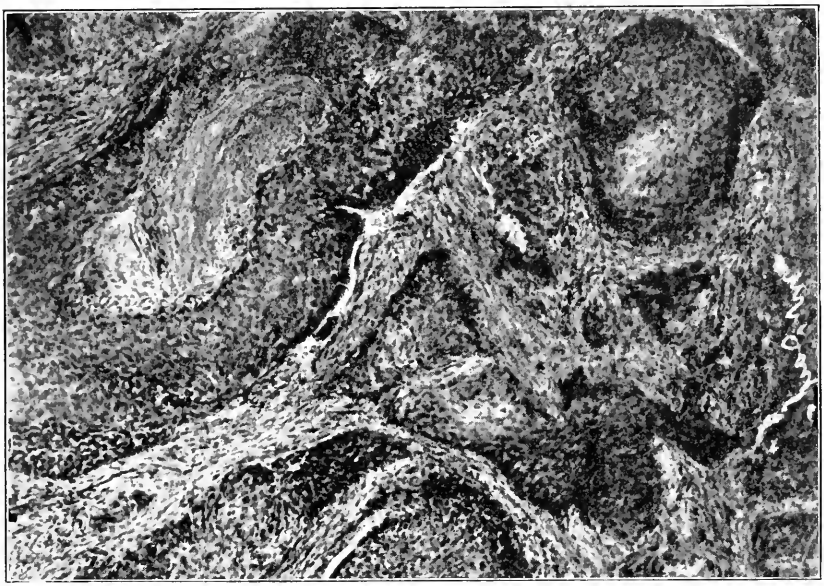


FIG. 313.—Section of cancer in case of a man, aged sixty-one years, that involved the lip, jaw, sublingual glands, and alveolar structures, which was treated as pyorrhea alveolaris for a long period of time until properly diagnosticated.

Fig. 313 is a section of a growth which is an example that should be particularly borne in mind by dentists. The patient, a man, aged sixty-one years, was treated by a dentist for so-called pyorrhea alveolaris affecting the lower incisor teeth. These were later removed and a piece of bridge-work inserted. A tendency to persistent disease of the mucous membrane under the bridge was treated for some months. Quite by chance he came under the care of another dentist, who immediately removed the bridge-work and advised proper examination. When referred to the author there was evidence of a slight progressive ulceration involving the gum and mucous membrane in the anterior part of the jaw. Sections of tissue from the gum, sublingual glands, under surface of the tongue, other portions of the floor of the mouth,

and adjoining border of the lip showed carcinoma. Thus under the very eyes of the dentist the case had progressed from a simple condition to the point of utter hopelessness, because proper treatment would have meant complete resection of the lower jaw, removal of the tongue and floor of the mouth and glandular structures throughout the neck, with little hope of survival and none for future comfort.

Both surgeons and dentists should be on the lookout for malposed, impacted, or unerupted teeth, especially late in life, and use the *x*-rays whenever necessary to determine their presence.

The following cases of the author were allowed to reach a hopeless condition before the cause was discovered.

A woman, aged sixty years, gave a history of necrotic condition of the lower jaw, which was due to an unerupted tooth. Its removal, however, was not accomplished until carcinoma was well under way and had involved other structures extensively.

A woman, aged seventy-one years, had worn artificial dentures for many years. A cuspid tooth was found lying close under the floor of the nose, and resulted finally in sarcoma and death.

A man, aged about thirty-seven years, had an impacted lower third molar. Before coming under the author's care the disease had progressed beyond operative limitations.

If the first sources of irritation had been discovered in these cases before malignancy developed, the author believes there would, in all probability, have been no malignancy in that region. Even if discovery had not occurred before this prompt diagnosis would have made it possible to operate successfully.

CHAPTER IX.

DISEASES OF THE MAXILLARY SINUS.

In the light of present knowledge of the nasal accessory sinuses in man it is evident that pathological conditions of the maxillary sinus are so often intimately related to diseases of the other accessory sinuses that both the etiology and treatment of any one of them must be more or less governed by the influence of others that may be involved.

A chapter devoted to consideration of the maxillary sinus would therefore be out of place in this work, without description in detail of the surgical and therapeutic measures required for the treatment of each one of the accessory nasal sinuses, were it not for the fact that the maxillary antrum has also an important relation to diseases of the buccal cavity. These can best be understood and diagnosticated by those whose training has made them conversant with affections of the jaws and teeth, and it is of the utmost importance that the subject be given the fullest possible prominence from this point of view.

The author is deeply impressed with the urgent need of development of maxillary sinus treatment along these lines; he is also no less convinced that operations upon the frontal, ethmoidal, and sphenoidal sinuses and cells can, for the greater part, be more successfully performed by operators whose field of practice is confined to the nose and its diseases; therefore the reader is referred to the works of this character for more complete description of operations upon these sinuses.

For many reasons this line of demarcation is not clearly defined. Many cases could be cited in which some undiscovered septic condition of the mouth has caused recurrence and continuance of maxillary sinus disease in spite of repeated and otherwise perfectly performed operations by those who were unfamiliar with pathological affections of the oral cavity and its associated parts. On the other hand, an equal or perhaps greater number might be described in which long suffering and ultimate disaster were brought about through failure to diagnosticate and establish a cure of disease of the nose or nasal accessory sinuses. The operator, though skilled in mouth treatment, could not do without aid, which was not sought at a sufficiently early date, detect the existence of the counteracting conditions.

The author's purpose is to cover the subject of the maxillary sinus and its diseases in all respects as to make possible a more general common understanding of the important features of these affections. This he hopes will lead to a more satisfactory coöperation than there

has been in the past between dentists, rhinologists, specialists in sinus operations, and oral surgeons, to the end that better results from treatment may be assured.

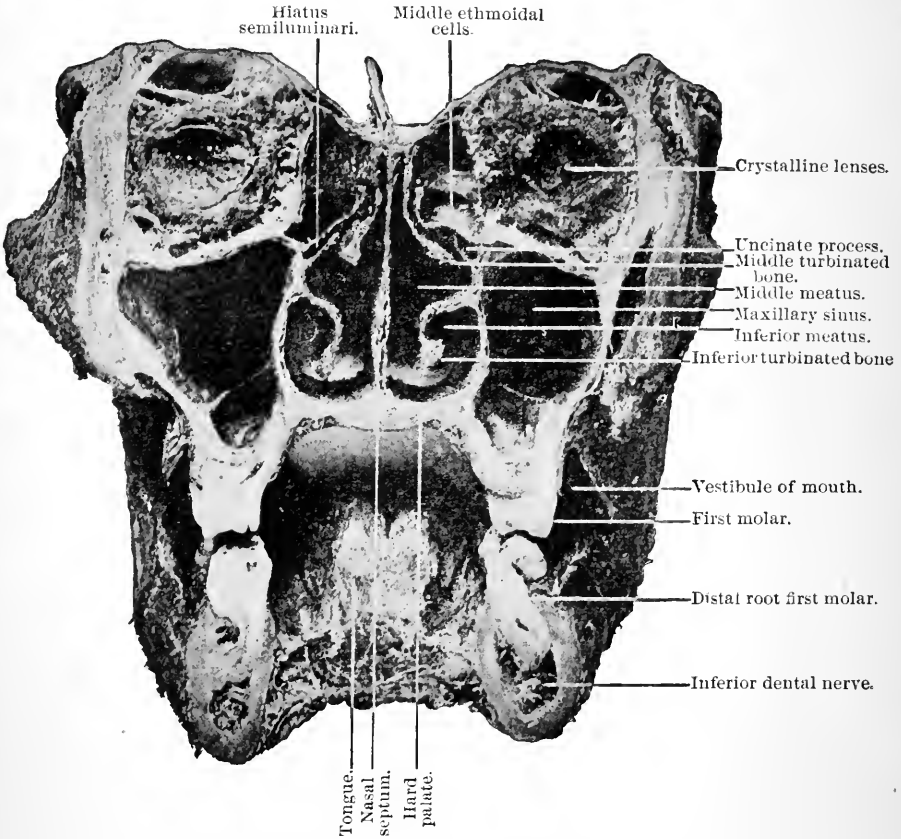


FIG. 314.—Anterior view of a vertical transverse bilateral section of the head, showing the relations of the jaws and indicating the positions of the turbinates, antra, etc.

Anatomical Considerations.—The maxillary sinus (antrum of Highmore) is the largest air cavity associated with the nasal chamber (Fig. 314). It is situated in the body of the maxilla on each side. The shape, size, and thickness of its walls vary greatly in different individuals and frequently upon the two sides of the same individual. The controlling influence in this respect may be said to be age, race, the presence or absence of teeth and tooth germs within the jaw, and developmental conditions influencing surrounding bones. It is lined with mucoperiosteum surmounted by ciliated epithelium. The typical sinus is pyramidal in shape, the apex being toward the malar bone.

Schaeffer[1] gives the following averages based on the measurements of 90 adult specimens:

	Millimeters.
Dorsosuperior diagonal	38.0
Ventrosuperior diagonal	38.5
Supero-inferior	33.0
Ventrodorsal	34.0
Mediolateral	23.0

The five walls are the inferior (floor), anterior (facial), posterior (zygomatic), superior (roof or orbital), and proximal (nasal).

The ostium maxillare, an oval-shaped foramen usually situated on the upper anterior portion of the proximal wall, gives communication between the sinus and the nasal fossa through the hiatus semilunaris.

Partial bony or membranous septa extend across the sinus in some cases, and are a frequent source of trouble in treatment. Whether these ever are complete, as claimed by some authors, is still a matter of more or less uncertainty.

Eminences upon the floor mark the outline of the roots of teeth, which are sometimes in direct communication with the sinus.

Classification of the Diseases of the Maxillary Sinus.—(1) Acute catarrhal maxillary sinuitis; (2) chronic catarrhal maxillary sinuitis; (3) acute suppurative maxillary sinuitis; (4) chronic suppurative maxillary sinuitis or chronic empyema of the maxillary sinus; (5) diseases of the bony walls of the maxillary sinus; (6) foreign bodies in the maxillary sinus; (7) infectious diseases; (8) polypi; (9) cysts of the maxillary sinus; (10) tumors.

Etiology.—Predisposing Causes.—Since drainage and ventilation are essential to the health of a mucus-lined cavity, anomalies of development in the form of the structures of the nose, the nasal accessory sinuses and their ostia, may predispose to maxillary sinus disease. Irregular, supernumerary, diseased, neglected, and uncleanly teeth and mouths may also favor these affections. Conditions of general health, age, sex, climate, exposure, habits of life, and similar factors, insofar as they may tend to reduce resistance to pathogenic microorganisms, likewise act as predisposing influences.

Exciting Causes.—In a general way and approximately in the order of their frequency these may be said to be *extension of disease* from the nose, mouth, other nasal accessory sinuses, or from the orbit; *occlusion* of the ostium maxillare; *infection*, either through the nose, mouth, or other accessory sinuses, or through the circulatory channels; *traumatic injury; cystic formations* in the mucous glands, or those connected with the surrounding walls; and *neoplasms* primarily situated in the antrum or involving it by invasion.

Nasal Etiological Factors.—It is known that with *acute coryza* (acute rhinitis) there may be extension of disease to the maxillary sinus by continuity of mucous membrane surface, and infection. As

[1] Ann. Otol., Rhinol., and Laryngol., December, 1910.

a result, hypersecretion involves and engorges the maxillary sinus. Therefore the causes of acute rhinitis, which are infinite in number, may also be accounted exciting factors in the causation of maxillary sinus disease. Among these more particularly might be noted infection by the Micrococcus catarrhalis, Bacillus segmentosus,[1] pneumococcus, and the infections of influenza, typhoid, smallpox, measles, diphtheria, and other exanthematous fevers. Chronic rhinitis with turgescence, hypertrophic rhinitis, hyperplastic rhinitis, and atrophic rhinitis may result from factors already described as leading to acute rhinitis. This is especially true when there are deviations of the

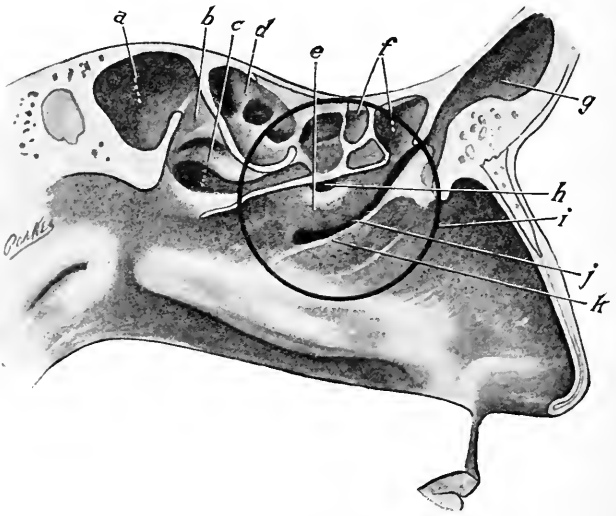


FIG. 315.—The "vicious circle" of the nose; *b*, the spheno-ethmoidal fossa; *c*, the superior turbinated body; *d*, posterior ethmoidal cells; *e*, bulla ethmoidalis; *f*, anterior ethmoidal cells draining into the frontonasal canal; *g*, frontal sinus; *h*, the ostium of the bulla ethmoidalis; *i*, hiatus semilunaris; *k*, the uncinate process or outer wall of the infundibulum or gutter on the outer wall of the nose into which the frontal, anterior ethmoidal, and maxillary sinuses usually drain. The high light below and anterior to *j* and *k* indicates the inferior boundary of the infundibulum or gutter into which the sinuses drain. The middle turbinated body is removed to exhibit the anatomical details beneath it. (Ballenger.)

septum or other nasal obstructions which in the course of chronic disease may cause turgescence of the "swell bodies" of the inferior turbinates and hyperplasia of the mucous membrane of the middle turbinal, the ethmoidal cells, and other structures. Under these conditions there is usually retention of secretion by the close approximation of the septum to the middle turbinate, and the resulting unhealthy conditions cause this to act as an irritant in passing over the mucous membrane of the middle and inferior turbinate, thus giving rise to morbid changes in these structures. Whether purulent, serous, or

[1] Walter: Jour. Am. Med. Assn., p. 276.

mucous in character, the secretion frequently fills the maxillary sinus through the ostium, which at times becomes obstructed and results in its engorgement. This mucous engorgement of the maxillary sinus has by some authors been described as a distinct disease, whereas it is properly only a symptom occurring in the course of other pathological conditions. Affections of the vasomotor nervous system and general diseases, such as diabetes, scorbutus, rheumatism, and similar disorders, are quite commonly associated with both acute and chronic disease. Nasal polypi in the region of the ostium maxillare not infrequently cause obstruction and lead to maxillary sinus disease.

The obstructive lesion, according to Ballenger,[1] may be a *deflection of the nasal septum*, an enlarged or *cystic turbinate*, an enlarged *bulla ethmoidalis*, or *cells in the uncinate process*, the median wall of the infundibulum. The area to be examined is shown in Fig. 315 within the circle. These structures he has designated as the "key" to inflammation of the sinuses, or the "vicious circle" of the nose.

Nasal operations may lead to infection of the sinuses. *Injudicious dressings, foreign bodies in the nose*, either in the form of splints or dressings or those of accidental lodgment, may excite irritation by blocking the ostium or damming back the secretions until they are forced into the sinuses and cause sinuitis.

Nasal polypi may cause obstruction leading to unhealthy conditions or be so situated as to obstruct the ostium directly and thus cause sinus disease.

Oral Etiological Factors.—There has been and is at the present time much diversity of opinion with regard to the frequency with which diseases of the teeth and structures of the mouth cause antral disease. The older writers, if dentists, were for the greater part inclined to the belief that empyema of the maxillary sinus was almost invariably caused by diseased teeth, while authors with practices limited to the nose and its affections quite universally inclined to an almost opposite view. Today, with a better general understanding of diseases of the nose and mouth, the differences of opinion are less apparent, but there should be even greater unanimity in this respect.

Tiffany[2] says: "Diseases of the antrum occur as a result of injury, and as an extension from a diseased tooth."

Baer[3] quotes Brophy as claiming that at least 85 per cent. of the cases of antral disease are caused by the teeth. While very wisely calling attention to the fact that it would require the compilation of a great many cases to prove the matter one way or the other, he states that out of 28 cases that he himself has treated, 25 started primarily in the teeth, while 3 developed secondarily to primary involvement of the frontal sinus.

Ballenger states that the maxillary sinus may be infected from

[1] Diseases of the Throat, Nose, and Ear, 1914, 4th Ed.
[2] American System of Dentistry, iii, 562.
[3] Dental Cosmos, July, 1911, p. 761.

the nose or the teeth, the cases probably being about equally divided between these two sources of infection. McCurdy[1] quotes Dmochowski, who, after making 150 autopsies, holds that but few cases have a dental origin, and Fletcher, who examined 500 skulls, in 252 of which were abscesses of the upper molars, found only 12 molars perforating the floor of the antrum, and stated that he had never seen a case of antral disease caused by carious teeth.

Marshall has expressed the belief that alveolar abscess is the most common factor in producing suppurative conditions of the antrum of Highmore.

These differences of opinion can doubtless be explained as being chiefly due to the following reasons:

1. Diseases of the maxillary sinus, as of the other sinuses, has only recently been diagnosticated in approximate proportion to its frequency of occurrence. Therefore many cases not having an external dental lesion to call attention to their existence, and without objective nasal symptoms sufficiently marked to lead to discovery, have passed unnoticed. Under past methods of diagnosis the cases caused by diseased teeth were more likely to be recognized, and thus the larger percentage of undiscovered cases would be of nasal origin.

2. In the examination of dried specimens, direct openings from the roots of teeth into the maxillary sinus were found to be common. It was therefore argued that when the roots of such teeth bore evidence of abscess, these necessarily caused maxillary sinus disease. But it should be remembered that in the living subject the lining membranes of the sinus provide serviceable protection against the invasion of pyogenic microörganisms, especially when still further protected by the lymph wall of the abscess sac. It is now known that such an abscess may form at the root of the tooth, even within the bony enclosure of the antrum, without actual infection passing through the lining mucous membrane of the sinus.

In many cases of necrosis involving the bony walls, even when fractured, the same membranous protection is afforded. Unless the soft tissues within the sinus are ulcerated or punctured, as sometimes occurs unnecessarily through injudicious attempts at diagnosis or treatment, there often need be no antral disease other than the external lesion.

The author is convinced that no satisfactory estimate can be made as to the relative frequency of oral and nasal causes of antral disease. He believes that in the future the latter will probably be found to outnumber the former very greatly, owing to better diagnostic methods and improved treatment of the diseased roots of teeth, and above all, perhaps, because of the prevention of these by oral prophylaxis. He has seen large numbers of patients who suffered for many years from the local and general disturbances that were incidental to maxillary

[1] Oral Surgery, p. 115.

sinus disease and from many unnecessarily ineffective operations that might have been avoided had there been early recognition of quite simple and to the trained observer perfectly obvious diseases of the teeth and mouth, and for this reason he has no desire to underestimate the actual importance of careful study of and constant watchfulness for factors of this nature in diagnosis.

Other Nasal Accessory Sinuses.—Diseases of the antrum of Highmore may result from primary pathological conditions of the frontal, ethmoidal, or sphenoidal sinuses and cells, and these in turn are likewise affected secondarily from the maxillary sinus. Figs. 316, 317 and 318 are illustrations of conditions favorable to such extension of disease. The decision as to which one of the accessory sinuses most often communicates infection to the others necessarily depends upon the identification of the one most frequently diseased.

FIG. 316.—Anterior view of vertical transverse section in the region of the first molar teeth, showing anterior ethmoidal cells and a cell in the crista galli. The frontal sinus extends downward, becoming common with the ethmoidal cells and antrum. (After Cryer.)

Ballenger states that the maxillary sinus is perhaps more often affected singly than any of the other sinuses, because in about one-half of the cases it is infected from the teeth rather than from the nose, whereas the other sinuses are nearly always infected from the nose. Having a common source of infection, they are therefore more often simultaneously diseased.

He also claims that knowledge of the diseases of the sinuses in general has so greatly increased during the last few years that ethmoidal, sphenoidal, and frontal sinus affections are diagnosticated twenty times as often as they used to be. The author is convinced that in the near future the importance of these diseases from a patho-

logical point of view will be greatly increased, and they will be recognized much more frequently than at present.

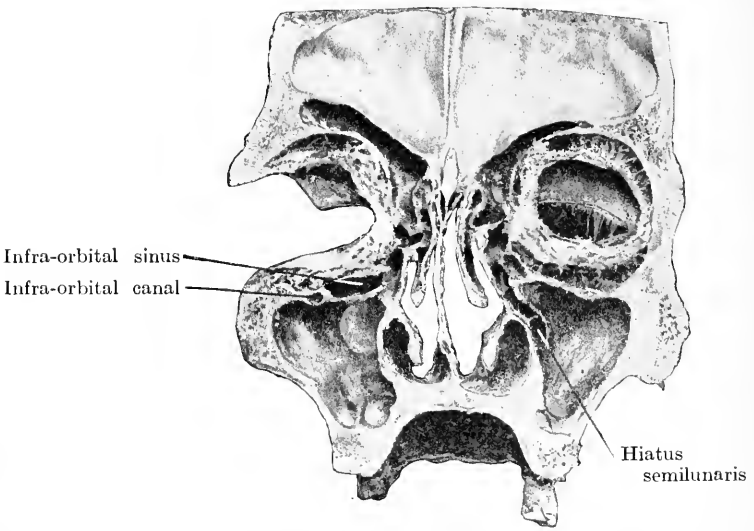


FIG. 317.—View of a vertical transverse section through the first molar teeth. The right hiatus semilunaris in this subject communicates with the maxillary sinus without a true ostium maxillare. (After Cryer.)

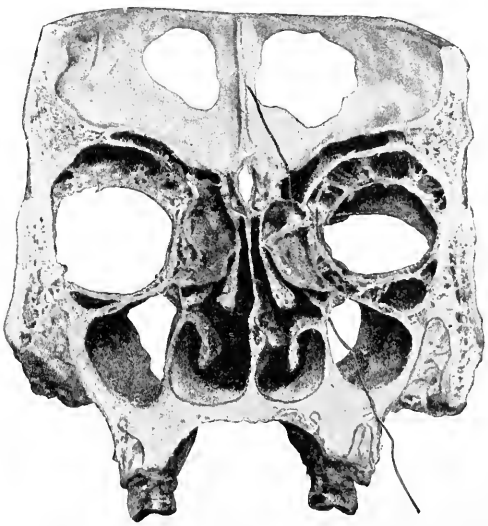


FIG. 318.—Anterior and posterior views of a vertical transverse section in the region between the second premolar and first molar teeth, showing a wire passing from the frontal sinus into the maxillary sinus. The frontal sinus extended downward to nearly the level of the upper portion of the antrum. (After Cryer.)

J. P. Tunis,[1] in his report on inflammations of the maxillary sinus with special reference to empyema, based upon the study of 100 unselected heads examined a few hours after death in the autopsy room of the Vienna General Hospital, gives the following conclusions:

"1. In the examination of 100 heads in the autopsy room, 37 per cent. showed some evidence of pathological changes in the maxillary antra.

"2. Of these 37 cases, 11 were examples of edema, 12 were examples of chronic inflammation of empyema, 1 was an example of an alveolar or dental cyst, and 13 were examples of retention cyst.

"3. With one or two exceptions all of these cases were undiagnosticated during life.

"4. The presence of a large amount of pus in 10 out of 12 of these cases of empyema may have played an active part in causing the death of the patients."

Schaeffer[2] says: "Of the specimens" (ninety) "studied to ascertain the frontomaxillary relations, 56 per cent. showed that the infundibulum ethmoidale was intimately related with the nasofrontal duct, or with the sinus frontalis directly in case the nasofrontal duct was wanting; 40 per cent. showed that the nasofrontal duct directly communicates with the meatus nasi medius, the infundibulum ethmoidale ending blindly or in air cells; 2.5 per cent. showed two nasofrontal ducts, one continuous with the infundibulum ethmoidale, and the other communicating with the meatus nasi medius; 1.25 per cent. showed a direct communication between the sinus frontalis and maxillaris.

"Since the infundibulum ethmoidale receives the ostium maxillare at its dorsal and inferior end in all cases, and the nasofrontal duct, or the sinus frontalis directly, at its ventral and superior end in over one-half the cases, it frequently serves as a gutter-like channel, of varying depth and efficiency, communicating between the frontal region and the sinus maxillaris.

"The sinus maxillaris therefore acts as a reservoir for fluids coming to the dorsal end of the infundibulum ethmoidale (the ostium maxillare being patent).

"Frequently the processus uncinatus by a superior curving at its dorsal end causes the infundibulum ethmoidale to end in a pocket. This pocket is so situated that it directs fluids coming to the dorsal end of the infundibulum ethmoidale into the sinus maxillaris *via* the ostium maxillare, which is in the immediate vicinity.

"Occasionally branches of the superior alveolar nerves in passing to the superior dental plexus pass entirely through the walls of the sinus, thence under cover of the mucous membrane of the cavity to their destination. Rarely the anterosuperior alveolar ramus, instead of taking its usual course, passes diagonally from the roof of the sinus

[1] Laryngoscope, October, 1910.

[2] Ann. Otol., Rhinol., and Laryngol., December, 1910.

to its ventral wall—the nerve thus suspended freely in the cavity is merely covered with the mucous membrane."

Dr. Walter V. Brem, of Los Angeles, formerly of the Colon Hospital, Cristobal, Canal Zone, has given the author a most interesting record of his postmortem examinations of the accessory sinuses while acting pathologist at the Ancon Hospital. The sphenoidal, frontal, and maxillary sinuses were examined in about 300 bodies of patients who died of various diseases. Of these, about 140 deaths were due to pneumococcus infections. All cases of Pneumococcus meningitis showed purulent inflammation of one or more of the nasal accessory sinuses. About 70 per cent. of the pneumonia cases showed the same thing. Purulent involvement was found not infrequently in other cases, and chronic and subacute inflammations in about 40 per cent. In approximately 14 per cent. of the non-pneumococcic deaths, pneumococci were present in one or more of the sinuses. Cocci and unidentified bacilli were frequently present. In many of these sinuses the lining membranes were thickened, and moist and stained smears showed pus cells and bacteria.

Circulatory Channels.—Diseases of the blood and infections carried through the circulation may affect the maxillary sinus in the same manner as the other anatomical parts. The character of the lesion would necessarily depend upon the nature of the infection.

Traumatism.—Traumatism through injury to external structures may excite inflammatory conditions, which in the course of their progress sometimes involve the antrum, or fracture of the bony walls may open the way for infection. It has been usual in the author's experience to find that fractures of the superior maxilla, including the walls of the maxillary sinus, even though there may be considerable discharge of pus, rarely cause continued empyema. In most cases the lining membranes of the sinus protect it against direct infection if these are not lacerated, and even when infection has occurred and an acute empyema has resulted, the symptoms quickly subsided after the fracture was united.

Symptoms.—Acute Catarrhal Sinuitis.—*Pain.*—In this form of sinus disease there is a sense of fulness on the affected side, or pain which is sometimes manifested in the form of a dull headache, although occasionally it is more severe and quite generally distributed over the frontal, occipital, and facial regions. It may be acute, distinctly infra-orbital or supra-orbital, or be chiefly confined to the eyeball through pressure from beneath the floor of the orbit.

Discharge.—The nasal discharge in acute rhinitis, which usually accompanies this class of cases, is often so active as to prevent the sinus discharge from being recognized as a distinct diagnostic feature.

Chronic Catarrhal Maxillary Sinuitis.—*Discharge.*—These cases usually give history of previous acute catarrhal attacks. The buccal and palatal walls of the sinus are almost invariably thin, and yield to pressure on account of enlargement of the sinus through being filled

with fluid and long continuation of disease affecting the bony walls. Unilateral discharge is usually a more or less constant symptom, and when not sufficiently marked, intranasal examination will almost invariably disclose that the naris on the affected side gives evidence of some form of chronic rhinitis. Usually *tissues surrounding the ostium appear diseased*, and occasionally *polypi* within the maxillary sinus may be diagnosticated through the ostium by intranasal examination. More often polypi limited to the nasal meatus are present, although this is not pathognomonic of antrum suppuration, as was formerly supposed.

Pain.—Pain in these cases is usually not severe, may be entirely absent, or may appear and disappear from time to time as repeated engorgements of the sinus occur, or there may be distinct involvement of the fifth nerve, especially the infra-orbital division which passes across the walls of the sinus and in many cases lies completely within the bony encasement, protected only by the lining membranes, and therefore easily subject to pressure from fluid or the direct influence of continued inflammatory conditions. Chronic neuralgia, sometimes in the form of tic douloureux, is frequently associated with these cases.

Acute Suppurative Sinuitis.—The symptoms of acute empyema are much like those of acute catarrhal conditions, except that owing to the presence of pus and formation of gases, the symptoms are likely to be in all respects more severe, both pain and pressure being, as a rule, quite marked. The unilateral discharge is more often a prominent feature, and the dripping of the foul secretions into the pharynx is a noticeable and disagreeable symptom.

Chronic Suppurative Sinuitis.—*Discharge.*—Unilateral discharge is a characteristic symptom of these cases, but is not always a dependable indication, because infection may extend to the opposite sinus, and with the maxillary antra on both sides diseased, the discharge would probably be bilateral.

Pain.—Pain may be entirely absent except during occasional acute attacks, or may be of general character; it may be distributed through the various divisions of the fifth nerve on the affected side or confined to one of them; and it may appear to be directly connected with the affected sinus, or reflected to some more remote division. There may be tenderness to pressure in the region of the infra-orbital or the supra-orbital foramina, or both. Slight or severe pain may be felt in the eye or may be entirely absent, or only sufficient to produce a stiffness in movement, or the floor of the orbit may be forced upward by pressure sufficiently to excite pain in the eyeball and cause it to be so compressed as to have the appearance of glaucoma.

Other Symptoms.—The bony walls of the antrum may be bulged outward and cause noticeable swelling on the affected side, or there may be no outward sign of the disease other than the thinness of the external wall, which causes it to yield to pressure with a more or less crepitant sound. Examination of the ostium usually discloses dis-

charge of pus, which, if wiped away, appears again. By packing the ostia of the other sinuses and applying suction, the pus from within the maxillary sinus can be brought into view. In many of these cases there is a history of awakening in the morning with a foul mass of secretion in the pharynx, an unpleasant odor which disappears during the day, and a sense of fulness or even pain which is relieved by lying with the face turned upon the opposite side.

Differential Diagnosis.—The clinical aspect of maxillary sinus disease so seldom presents a typical series of symptoms that it is frequently necessary to make diagnosis from some one or more of the indications which lead to suspicion of the existence of the affection. Under these circumstances it is important that a number of diagnostic aids should be employed in order that a correct diagnosis may result.

Nasal Discharge.—In acute maxillary sinuitis the unusual secretion and other symptoms which accompany ozena are unmistakable. Quite frequently upon stooping or turning the head upon one side there is a momentary gush of fluid from the nose. In chronic cases the only indication of unilateral discharge may be an unhealthy appearance at the external opening of the naris on the affected side, or the patient may admit being barely conscious of freer discharge from one naris than the other. There may or may not be a foul odor from the nasal secretion or from the patient's breath; on the other hand, constant dropping of foul secretion from the nasopharynx is sometimes a distinguishing feature, or this may only be noticed upon waking in the morning. In marked cases the unilateral nasal discharge is quite evident. A sense of fulness and discomfort when the patient lies with the head turned upon the affected side, which is correspondingly relieved by lying upon the opposite side, or cessation of the discharge when lying upon the back, are symptoms of importance. The presence of diseased secretion in the maxillary antrum, when not otherwise demonstrable, may be tested by suction applied at the ostium maxillare to draw out the fluid and allow its nature to be determined. In differential diagnosis to decide whether the case is one of simple empyema (confined to one sinus) or whether the discharge comes from the maxillary or some other sinus, pack the region of the ostia of all the sinuses except the maxillary and then apply suction. In open empyema (with the ostium open) these tests will be efficient, and in closed empyema (with the ostium closed) the result will be negative.

In latent empyema, a case in which the ostium is not fully closed and not completely open, secretion may be drawn from the sinus, but not as freely as in open empyema cases.

Intranasal Examination.—Internal examination of the nose will sometimes show an appearance of ulceration or other disease of the mucous membrane in the region of the ostium. This indicates that it is more or less constantly bathed with vicious fluids, even though

this may not be apparent through an external discharge and may not at the moment be otherwise demonstrable. It must be remembered that in chronic antral disease there is great difference in the quantity and nature of the secretions at different times. An ordinary open ostium may for the time being be closed by inflammatory processes affecting the surrounding mucous membrane, or be occluded by a polypus or some other obstruction, and thus in effect be the same as closed empyema. The inner wall of the antrum is sometimes forced toward the septum.

Pain.—In acute cases, whether the fluid be pus or other secretion, the pain sometimes is intense owing to pressure upon the nerve as previously described. In chronic empyema the same condition may occur during acute attacks, or for the same reasons there may be periods during which pain may be distributed over the entire side of the face and extend to the frontal, temporal, and occipital regions. As the engorgement of the antrum becomes relieved, this pain gradually subsides. These cases are frequently mistaken for periodic migrainoid headaches until the antrum disease is discovered by other diagnostic indications. Pressure over the malar bone or the infra-orbital or the supra-orbital foramina may elicit tenderness. A more or less considerable skin surface may be so hyperesthetic as to be sensitive to the slightest touch. Supra-orbital or infra-orbital neuralgia or pain reflected to other divisions of the fifth nerve or tic douloureux may be manifest with maxillary sinus diseases. None of these may be considered pathognomonic, because many other sources of irritation give rise to similar symptoms, but taken with other corroborative diagnostic signs their significance is valuable.

In rare cases the sinus may be so greatly enlarged as to cause a bulging outward of the cheek upon the affected side until it appears to be swollen, but unless the infection finds its way through the walls of the sinus into the overlying soft tissues there is no actual swelling of these structures. Much more frequently the buccal wall is sufficiently enlarged and forced outward to be easily recognized in oral examination. Pressure with the finger along this wall usually discloses one or more points at which the bone is exceedingly thin and yielding, often with a crepitant sound upon pressure, especially when there has been a long-continued necrotic condition of the sinus.

The *palatal wall* in chronic cases is generally thin and yielding, and not infrequently bulged out of form through enlargement of the sinus.

Teeth.—The teeth upon the suspected side should receive an exceedingly careful examination. If diseased roots of teeth are present they must be tested to determine whether they may not have been the first cause of the antral disease. The socket of any diseased root that it may be necessary to extract should be disinfected and a probe forced gently upward to the end of the alveolus, to determine whether it actually enters the sinus cavity. Great care should be exercised

to avoid forcing the probe upward in such a manner as to carry infection that might not otherwise reach it directly into the sinus.

When there is no evidence of *dental caries* or *dento-alveolar abscess*, teeth with fillings should be tested with hot gutta-percha, hot instruments, or ice. The light reflected from an electric mouth lamp should be employed to ascertain the condition of the tooth pulps. If the tooth crowns are dark and it is evident that the pulps have been devitalized in the course of treatment or through some pathological process, the question as to the proper filling of the roots must be determined.

The absence of a normal tooth from the jaw upon the affected or suspected side must be accounted for either by history of previous extraction or its position if unerupted must be definitely determined. The presence or absence of *supernumerary* teeth must also be considered and tested. Interstitial *gingivitis*, ulcerative or other forms of *stomatitis*, will be readily recognized, and with a probe the passageway for infection located.

Transillumination.—The patient is placed in a dark room and the lips are tightly closed around an electric light held in the mouth. When the appearance is as shown in Plate XVIII, and there is opacity over the lower eyelid, a non-luminous pupil, absence of sense of light when the eye is closed, and a darkened area outlining the antrum on the affected side, the indications would point to empyema of the maxillary sinus. The difficulty, however, with this method of diagnosis lies in the fact that maxillary antra sometimes vary so greatly in the size and thickness of their walls in the same individual. The author has repeatedly noted marked opacity upon one side in the region of the maxillary sinus in comparison with the opposite one, even when both antra were normal.

Ballenger, who recognizes the uncertainty due to anatomical differences, says the three points to be noted in transillumination are: (1) The red pupillary reflex; (2) the crescent of light corresponding to the position of the lower eyelid; and (3) the sense of light in the eye when closed. If the red pupillary reflex and the crescent of light are absent the antrum is probably affected. By noting both sides at once it may be determined which side, if either, of the maxillary sinuses is affected.

Radiographs.—The use of the *x*-rays is undeniably valuable in these cases. It is the most reliable method of determining the etiological relation of teeth and roots in many respects that otherwise might be exceedingly difficult or impossible to distinguish. Root fillings that have been imperfectly inserted, crowns attached with pins that project through the sides of the roots, extensive dento-alveolar abscesses, and the acute penetration of roots into the antrum, as well as the presence and situation of impacted teeth, may be causes of maxillary sinus disease or the presence of such teeth within the maxillary sinus itself.

Fractures and diseased conditions of the antral walls that might

PLATE XVIII

Right Left

Transillumination of the Antra. (Coakley.)
Right, healthy; left diseased.

otherwise escape notice are also shown by this aid. How far the average radiograph may be trusted in portrayal of the disease itself is a matter of grave question. Sometimes, undoubtedly, empyema is plainly discernible in this way; but it is not safe to be too positive in regard to this evidence without confirmation from some other indication.

FIG. 319.—Radiograph showing left maxillary sinus cloudy when compared with the opposite antrum, an indication that it is full of pus.

Puncture.—Puncture of the maxillary sinus through the inferior meatus to permit the withdrawal of its contents by suction, aspiration, or washing out through the ostium is one of the final methods of determining the actual state of the sinus. Puncture with a trocar and cannula through the anterior wall gives the same result, and if carefully done is not likely to cause infection, but carelessly done, a previously healthy sinus might be infected.

Prophylaxis of the Maxillary Sinus.—Study of sections of the heads of embryos shows that from the fourth month of embryonic life when development of the maxillary sinus takes place by invagination of the lining membrane of the nose from the hiatus semilunaris, until birth, certain marked changes take place. All of these are subject to developing dental organs, and after birth this same developmental dependency continues throughout the period of growth.

With these principles rightly comprehended, it must be apparent that in the course of the development which precedes the eruption of the permanent teeth, and afterward during their existence, oral hygiene, oral and dental prophylaxis, the care of children's teeth, and above all prompt attention to the early expansion of dental arches (described on pp. 550 and 551), are measures of vital importance in endeavoring to avoid pathological states of the maxillary and accessory sinuses.

Laying aside for the moment all corroborative knowledge gained through unlimited and undisputed clinical evidence of the frequency of pathological conditions of the nasal accessory sinuses in individuals who have any of the associated nasal, palatal, or maxillary malformations, the result of restricted maxillary growth upon the nose, as shown in the groups of sections of dogs' heads (p. 566), is alone sufficient to banish every doubt of the great advantage as a preventive measure of giving free and unrestricted growth to all this region, by prompt and efficient separation of the maxillæ.

Similarly, any abnormal tendency evidenced in the nose and throat should receive treatment. The removal of adenoids, of enlarged tonsils, and the correction of hypertrophic or other intranasal conditions that predispose to disease are demanded quite as much for the prevention of future sinus disease as for the immediate remedial effect upon the nasal condition.

Surgical Treatment of the Maxillary Sinus.—The following operations are the ones usually employed: (1) Alveolar, (2) palatal, (3) intranasal, (4) Kuster, (5) Caldwell-Luc, (6) Denker, and (7) Canfield-Ballenger.

Alveolar Operation.—The alveolar operation, sometimes called the Cooper operation, has been extensively practised in this and other countries. In this method a tooth or root was extracted and its socket enlarged and elongated until an opening into the antrum was effected. In edentulous jaws an opening was made through the alveolar ridge of the mouth into the sinus. Irrigation and drainage through this opening were supplemented by the use of drainage tubes of rubber or metal, which were kept in place by attachment to teeth or to plates resting on the surface of the jaws.

It seemed a most radical and effective surgical procedure after the earlier and still less effective plan of treatment by irrigation through the root canal of a tooth, which most dentists formerly employed.

Large numbers of cases of antral empyema have been successfully treated by the alveolar method, but other operations are to be preferred, principally for the following reasons: (1) It is not always necessary to sacrifice a tooth because the maxillary sinus is diseased. No tooth should be lost that a skilful dentist can make useful and cure with sufficient certainty to remove danger of future infection from this source. (2) The thickness of bone structure between the

apical end of the alveolus of the extracted tooth root and the sinus is usually greater than one unaccustomed to the operation would expect. Raw surface is thus exposed to infection, and more pain caused in packing or irrigation than is necessary for even more radical operations. (3) In many cases it is impossible to gain complete access to all parts of the sinus through openings of this kind and of the size usually recommended. (4) No drainage tube can be inserted with certainty of giving complete drainage for a sufficient length of time to be effective. Those worn, as many were, for periods of ten, fifteen or twenty years, simply served to prevent acute attacks and also as effectively prevented the possibility of cure.

It is frequently advisable to extract one or more diseased teeth when these are etiological factors or a menace to the future health of the sinus. In such cases the socket should be reamed out and the opening enlarged, but the regular operation for radical treatment must be performed without reference to the alveolar opening, except that by extending it to the tooth socket the fullest possibility of access and drainage is secured.

Palatal Entrance.—Treatment through an opening in the palatal wall may sometimes be necessary when pus has already found an exit in that direction and a large portion of this bone surface has been destroyed. Those who are familiar with the difficulty of keeping the antrum clean during the very slow progress of closure of an opening in this situation are not likely to adopt it as a regular procedure when once cognizant of the advantages of other methods. When this is done, however, it is possible to curette and pack the sinus quite satisfactorily.

Intranasal Operation.—Puncture of the naso-antral wall and irrigation through a cannula are sometimes all that is necessary for the cure of acute inflammatory conditions of a maxillary sinus, especially when there is no history of similar attacks. The trocar and cannula may be passed through the naso-antral wall at the inferior meatus or the anterior wall at the canine fossa. The naso-antral entrance is preferable because it offers less opportunity for infection. A cannula can be passed into the antrum almost as easily at this point as through the oro-antral wall at the canine fossa. If carefully done, however, puncture through the thinnest portion of the anterior wall offers an exceedingly direct and simple method of entrance; with proper antiseptic precaution the danger of infection need not be seriously considered.

When the trocar is withdrawn, a rubber tube is attached to the cannula, and through this irrigation with normal salt solution is continued until the fluid as it passes from the nose becomes clear and inoffensive. When the ostium is closed, whether it be due to abnormal development, temporary obstruction by inflammatory processes, polypi, or crusts, this method will not be successful, because the fluid will simply serve to increase the engorgement of the antrum and be likely

to cause more or less pain through increased pressure. In such cases, unless the opening through the ostium can be reëstablished, it will be necessary to make a second opening or to enlarge the one already made sufficiently to afford all fluids free exit.

Removal of the Naso-antral Wall.—In the performance of this operation a large opening is made through the naso-antral wall. Experience has proved that small openings from the nose into the maxillary sinus will close, but that a large opening will remain permanently open.

Local anesthesia and freedom from hemorrhage are secured by applications of cocain and adrenalin solution to the inferior turbinal and the inferior and middle meatus. The anterior half of the inferior turbinate body is removed with a knife, scissors, saw, or other suitable instrument. Baer dislocates the inferior turbinate upward, and after the operation is performed replaces it. He claims this is a material advantage because function is not so much impaired in this way as when a portion of the inferior turbinate is removed. With the inferior turbinate out of the way the naso-antral wall is punctured and a large portion of its surface removed. There are many ingeniously devised instruments for this purpose, as, for example, Vail's antrum saws, Corwin's antrum chisels, different forms of trephines and forceps, such as the Nobel-Cordes forceps (Fig. 320).

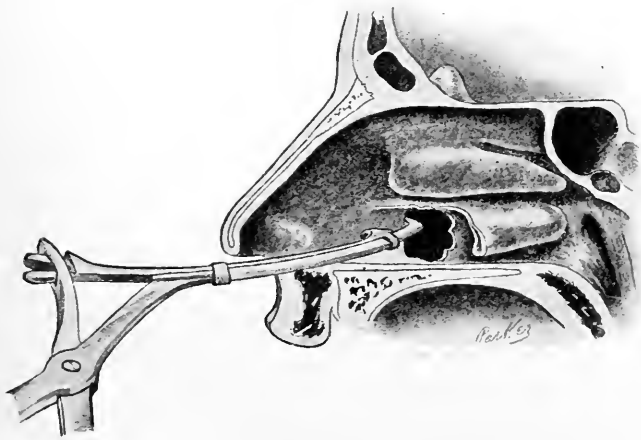


Fig. 320.—Removing the naso-antral wall with the Nobel-Cordes forceps. (Ballenger.)

Stein[1] uses his own notched gouge chisels (Fig. 321) for this purpose. He describes his method of performing the operation as follows:

"If a large opening into the antrum is desired one of two procedures may be followed: (1) For an opening with the removal of part or all of the lower turbinate. Enter one point of the V with the concavity

[1] Laryngoscope, St. Louis, February, 1910

of the instrument directed toward the floor of the nose, just within the pyriform process of the antral wall, driving backward and outward until the sharp point perforates into the antrum cavity, then, with the instrument still *in situ*, depress the handle and push backward; this gives a gentle upward curve through the thin bone of the middle meatus region, one blade of the V being in the antrum and the other in the middle meatus. As you progress backward gradually elevate the handle so as to direct the cutting V downward in the direction of the lower turbinate again, passing through it at any part the operator may select. Remove the instrument and reënter at the point of first incision, but with the handle elevated and the concavity directed upward, thus forcing the instrument below the turbinate, one blade of the V being in the antrum and the other one in the lower meatus. Gradually depress the handle so as to force the cutting V to follow as close to the floor of the nose as the thickness of the bone at this part will permit, causing it finally to meet the incision from above at the selected spot. The oval piece of bone made up of turbinate and naso-antral wall is removed with forceps *en masse*. (2) For an opening without removal of turbinal tissue. Enter one point of the V through the naso-antral

FIG. 321.—Stein's antrum chisel or gouge.

wall of the lower meatus, namely, below the inferior turbinate, at a point as high up under its anterior attachment as possible. Push backward, keeping the cutting V as high as can be. When the desired length of incision is reached remove the instrument and reintroduce at the beginning, only direct the cutting V as close to the floor of the meatus as possible, driving backward to meet the first incision above. By using two instruments, with one blade of the V longer than the other, this latter operation is made easier, the longer blade being the one to perforate into the antrum."

The Kuster Operation.—In performing this operation the anterior wall of the antrum is opened through the canine fossa. This opening should be large enough to permit the introduction of the index finger. In this way septa, sequestra of dead bone, and any abnormality in form of the sinus that may exist can be recognized, proper treatment applied, the sinus curetted and packed.

The author's method of performing this operation is illustrated in Fig. 322.

As a preliminary step the naris upon the affected side should be packed with gauze far enough back to cover the ostium and with a portion of the packing projecting out from the nose in order that it

may be quickly removed and changed if necessary and that there may be no danger of its working back into the pharynx during anesthesia. Unless this is done much blood may be lost through the ostium without its quantity being noted, and hemorrhage of this character adds considerably and unnecessarily to the danger of blood inspiration. Having packed the nose, a pad consisting of two or three gauze sponges clamped together at one corner with the forceps is placed between the teeth. With a retractor a corner of the mouth is drawn back out of the way. If necessary, another sponge may be packed into the corner of the mouth with a forceps attached for safety. In this way the patient is effectively protected against the danger of unusual hemorrhage, and the field of operation is quite clear.

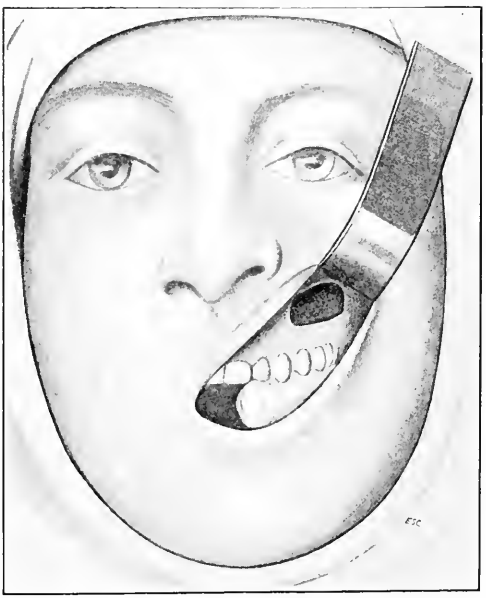


Fig. 322.—Anterior wall of the maxillary sinus opened at the canine fossa.

The upper lip is elevated and an incision made at the labiogingival junction, carried to the periosteum, and made sufficiently long to give free scope in the removal of the bony wall. Some little annoyance may be saved by picking up with a hemostat any small vessels which may threaten hemorrhage. The periosteum is raised sufficiently to expose the canine fossa.

By finger pressure the most yielding place in the anterior wall is readily discovered. The bone at such points is usually sufficiently thin to admit the passage of a reasonably stiff probe directly into the sinus in an upward, backward, and inward direction. A bur in a surgical engine is then passed through the bone following the direction

of the probe. The purpose of this is to prevent the possibility of such errors as have frequently occurred when through some anomaly of development of the sinus is unusually small and the naris upon the affected side much enlarged; or when some other unusual anatomical condition has made the exact situation of the sinus misleading, as a result of which the sinus has not been properly entered. The author has known of a number of cases in which irrigation had been continued for a long period without relief, until it was finally discovered that the opening made led into the nose and not into the sinus.

The bur is then carried forward until the anterior extremity of the sinus is reached, and backward as nearly as possible to its full extent in a posterior direction. The floor is sloped downward as much as may be permitted without injury to the apical ends of the roots of the teeth, and the opening enlarged until a finger can be inserted. When hemorrhage becomes excessive, packing tightly with gauze for a few minutes will usually serve to check it sufficiently to permit careful progress after its removal.

When the interior of the sinus is thus exposed by the aid of properly adjusted or reflected artificial light, satisfactory examination of the actual conditions may be made. One's finger quickly becomes accustomed to areas of bone that are rough and feel dead to the sense of the touch. Bony septa may be mere ridges extending across the floor of the sinus; or a septum may extend up so high as to appear to form the actual sinus wall, and thus lead the operator to believe that the sinus had been opened completely, when, as a matter of fact, the most diseased portion may lie behind this barrier.

Quite recently the author found what appeared to be a septum extending almost through the central portion of an unusually large sinus, and later discovered that it was the nasal wall which had been forced over into this position.

A dental or surgical engine bur should not be trusted as a substitute for a curette, because even with the greatest care much damage may be done to the surrounding parts. A bone curette will readily remove all bone that should come away except such as hereafter described. The extent of curettement depends entirely upon the nature of the disease. In long-standing cases of chronic empyema, when there has been extensive destruction of the lining membrane, and large areas of diseased bone are in evidence, the curettage must be complete; but when polypi are found and the lining membrane is merely in a hyperplastic condition, it is better not to make such extensive curettement as to expose the bone surface entirely.

Removal of the polypi and diseased mucous surface is all that is required, and the undisturbed periosteum favors more prompt recovery than when the bone is denuded.

The author's experience has taught him that when antra are unusually large, with an extension curving backward and inward, and the extreme point of the inner portion of this wall feels rough and yielding,

it is advisable to puncture in order to ascertain whether or not there is close contact with a diseased sphenoidal sinus (Fig. 323).

In a number of instances when patients gave a history of at least several previous radical operations for empyema of the maxillary sinus, and when upon opening into the sinus little or no pus was found, puncture at this point allowed pus to flow in considerable quantities from the sphenoidal sinus, or some cell connected therewith, which made direct communication with the maxillary sinus possible. After careful curettement, drainage, and irrigation, these cases were cured, as they otherwise could not have been, even though the sphenoidal sinus might have been opened by enlargement of its ostium and treatment in the usual manner.

These cases, of course, are rare, but they are likely to be those concerning which the prognosis is most grave; and it is incumbent upon the operator to bear in mind the possibility of their existence.

A *B*

FIG. 323.—Anteroposterior division through the center of the orbit, maxillary sinus, and molar teeth, showing a large maxillary sinus and a large sphenoidal sinus.

In chronic cases, when the sinus has been sufficiently curetted, the pressure against the nasal wall with the finger inserted through the opening in the anterior wall usually reveals that the bony separation between the nose and the maxillary sinus is thin and more or less diseased. This thin nasal wall can usually be broken quite readily by finger pressure and the thin bony flakes drawn away through the opening in the sinus, leaving only a membranous division between these two cavities.

This not only removes an element of danger of recurrence of disease from bone affected by nasal or sinus conditions, but it leaves the case in condition to be readily controlled if at any time it should prove to be absolutely necessary to have a large opening from the sinus into the nose, because it is only necessary in that event to cut through the soft membrane.

Last of all, the floor of the orbit should be carefully examined.

This wall is undoubtedly more often imperfect than the average operator realizes. The bone in places is exceedingly thin and non-resistant; many times its surface is incomplete as a result of destruction by disease or anomalous development, and there will be found to be one or more points at which there is only a membranous division between the orbit and the sinus.

Carelessness in curettement under these circumstances might easily cause serious damage to the organs through traumatic injury or infection.

Care should be taken to have the borders of the opening through the canine fossa smooth and symmetrical in order that packing may be easily performed with as little pain as possible. It should be packed with gauze, wrung out in compound tincture of benzoin, or 2.5 per cent. carbolic acid, or in syphilitic cases 1 to 10,000 solution of bichloride of mercury. No attempt should be made to use a solution that might be expected to act as a powerful germicide. The danger of irritation and of poisoning is too great. The purpose should be to prevent the gauze itself becoming a source of infection through absorption of bacteria-laden secretions. There is no need of powerful germicides when the work has been thoroughly performed with proper surgical cleanliness. Gauze used for packing should be folded into a long, narrow strip with the edges so turned in that threads of the gauze may not become detached and cling to the walls of a sinus at the time of removal, and thus become a source of future infection. The strip should be sufficiently long to fill the sinus completely and thus avoid error at the time of removal, because there will then be no chance of any portion being left behind. Moreover, its removal is facilitated, because it can be drawn out continuously from one end; and when packed into place a sufficient pressure will be made to check tendency to hemorrhage and to force the tissues away from the opening and give as unobstructed a view of the interior of the sinus as possible when the packing is removed. The buccal surface should be coated freely with collodion to keep out secretions and hold the gauze perfectly in place.

The first packing under ordinary conditions may be safely left forty-eight hours. This gives the patient time to recover from the effects of the operation. Afterward it should be changed daily, using a little less pressure from day to day. The number of times that the sinus should be packed will depend upon the character of the disease. On general principles the less packing an antrum receives beyond actual requirements the more will its return to healthy conditions be encouraged. In ordinary cases from one to three packings is sufficient. Old chronic cases may require the dressing to be changed daily for ten days.

The purpose of the packing is to allow the wound to become protected to some extent against infection by the formation of new granulations. As soon as this is accomplished the packing is left out and the patient instructed to irrigate through the sinus with saline or boric

solution twice daily. At intervals of two or three days a swab dipped in tincture of iodin may be used to wipe out the inner surface and the borders of the buccal opening.

The capillary drainage supplied by the gauze packing is undoubtedly an important factor, and much more effective than drainage tubes of any kind could be.

Most operators who have had occasion to treat chronic cases of empyema of the maxillary sinus, which had previously been treated according to the methods of a decade ago, will remember how often it occurred that foreign bodies found their way into the antrum through small openings, especially when treatment was made through the socket of the root of a tooth. When these sinuses were properly opened up all kinds of foreign substances were from time to time found lodged therein, such as old, foul-smelling pieces of cotton, pieces of gauze, hard- and soft-rubber tubes, metal tubes, portions of roots of teeth, pieces of instruments, fragments of wooden toothpicks, insoluble particles of food, etc.

Fig. 324.—Woman with chronic disease of both frontal and maxillary disuses. External fistulæ are shown at nose, eye, and brow.

Fig. 324 shows the picture of a patient, a woman, aged forty-eight years, who had been operated on through a small opening in the canine fossa, and had a Kilian operation performed upon her frontal sinus. At the time she came under the author's care, pus was discharging so freely from the frontal sinus, and through the side of the nose and maxillary sinus, that there was almost a continuous flow which dripped out upon the face. Upon examination it was found that her nose contained approximately two inches of badly rotted rubber tubing that had been passed from the mouth into the sinus and

had worked out through the ostium into the nose. This tubing had been lodged in that position for about two years. This was removed, and when the maxillary sinus was properly opened it was found to be partially filled with black-looking particles, which proved to be bismuth paste, that had been forced into the sinus evidently in the fond hope that it might effect a cure, notwithstanding the surrounding conditions. One complete operation, which included the maxillary sinus, the side of the nose, and the frontal sinus, was all that was necessary to check the offensive pus formation and set in motion progress toward complete recovery, which followed shortly afterward.

This is simply a marked illustration, but in its main aspect it is not unusual. The author has never had much sympathy with the use of bismuth paste (Beck's paste) in the treatment of maxillary sinus disease. For it has always seemed that there was no advantage in attempting to avoid the thorough and complete radical operation which such cases require; and that even though the bismuth paste might be effective in some cases, its use is unnecessary.

Removal of Foreign Bodies from the Maxillary Sinus.—When the roots of teeth from extraction have been forced into the maxillary sinus, or any other foreign substances that cannot be expected to pass safely out through the ostium, even though apparently harmless, they should be removed by opening up the sinus, as for the performance of a radical operation.

The author, after a number of years of rather wide experience in the treatment of maxillary sinus disease, has opened the sinus many times without an anesthetic; has used local anesthesia, nitrous oxide, oxygen, and ether, but has found ether the most reliable when radical operation is performed.

Caldwell-Luc Operation.—In this operation (see Fig. 325) the anterior wall of the antrum is exposed by an incision at the labiogingival junction, and the bone surface uncovered by separation of the periosteum and overlying tissues, in the same manner as for the Kuster operation, except that it is more carefully done in order to favor closure of the wound by sutures.

The bony wall is removed in precisely the same way. A large opening is then made through the naso-antral wall. To accomplish this the anterior half of the inferior turbinated body is sometimes removed with a swivel knife or with scissors or with a saw, and the opening from the nose into the sinus effected by the use of specially formed chisels and saws, or with a Nobel-Cordes forceps (as shown in Fig. 320), or some similar instrument; or the naso-antral opening may be made from the antral side, entrance being gained through the oro-antral opening, as prescribed for the Kuster operation, except that it is carried completely through the mucous membrane and a large naso-antral opening established. The end of a strip of gauze packing of sufficient length is carried into the sinus through the oral opening and out through the nasal opening into the nose, and its left slightly projecting from the

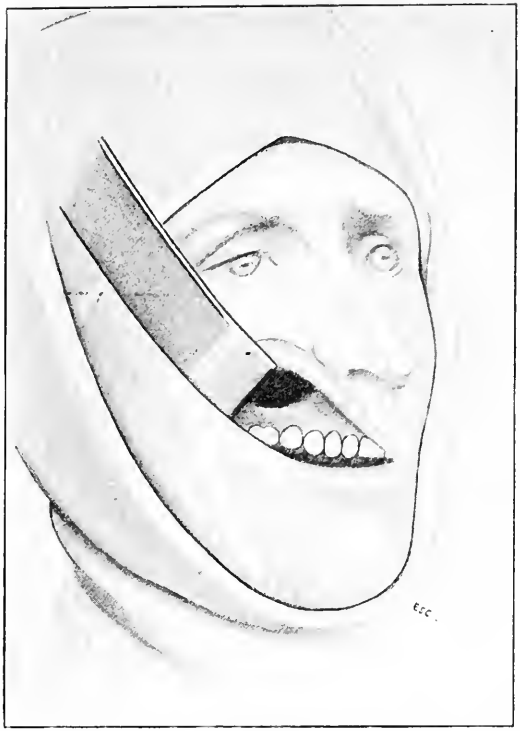


FIG. 325.—Anterior wall of the maxillary sinus opened for the Caldwell-Luc operation

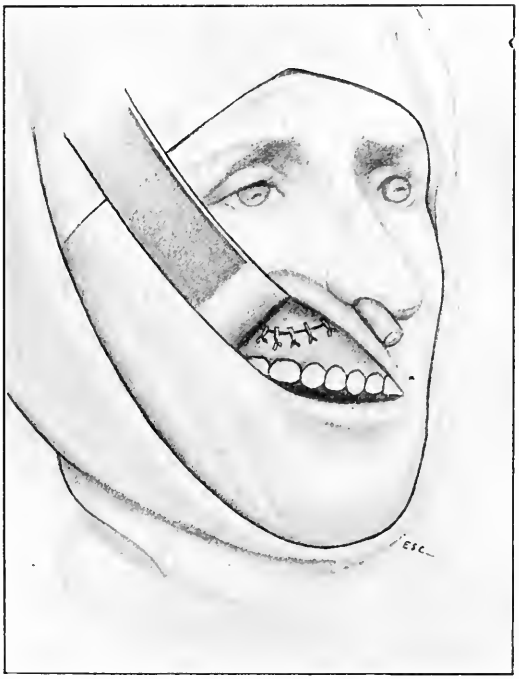


FIG. 326.—Caldwell-Luc operation completed by closure of the oro-antral opening.

external opening. With the remaining portion of the gauze strip the sinus is packed in such a manner as to permit of the immediate closure of the oral wound with catgut sutures, as illustrated in Fig. 326.

At the end of the second day the gauze packing is finally withdrawn through the nose, future treatment being in the nature of irrigation with mild antiseptic solutions.

The Denker Operation (Fig. 327).—In the Denker operation the anterior wall of the maxillary sinus is removed in the same manner as in the Kuster and Caldwell-Luc operations; and in addition to this the remaining section of the bone between the canine fossa and the lower portion of the pyriform opening of the nose is cut away. The sinus

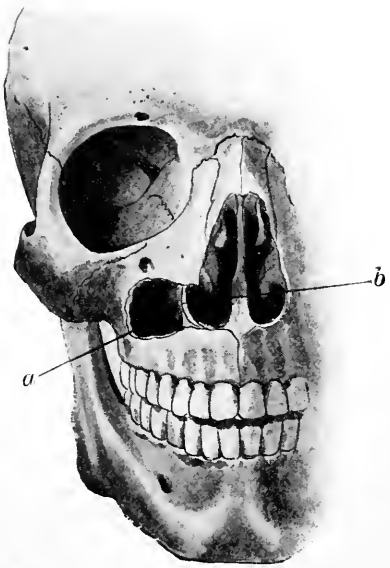


FIG. 327.—The Denker antrum operation: *a*, the area of bone removed in the Kuster and the Caldwell-Luc operations. In the Denker operation additional bone is removed from *b* to the pyriform aperture. (Ballenger.)

is curetted and diseased membrane, granulation tissue, polypi, or dead bone removed. The mucoperiosteum of the anterior meatus of the nose and of the inferior turbinated body is detached with a small, flat periosteal elevator of such form as to make it adaptable to the parts. From this a mucoperiosteal rectangular flap is cut and turned outward onto the floor of the sinus. The bony naso-antral wall and the anterior portion of the inferior turbinated body are cut away sufficiently to make as large an opening as for the Caldwell-Luc operation. The mucoperiosteal flap which has been turned onto the floor of the sinus is held into position for from twenty-four to forty-eight hours with a bismuth gauze dressing.

In after-treatment the parts are kept cleansed and the tissue, as

granulation takes place, is touched from time to time with tincture of iodin or caustics if required to check excessive granulation.

FIG. 328. — Canfield-Ballenger operation: *a*, the margin of the pyriform aperture, the point of incision for the Canfield-Ballenger antrum operation. (Ballenger.)

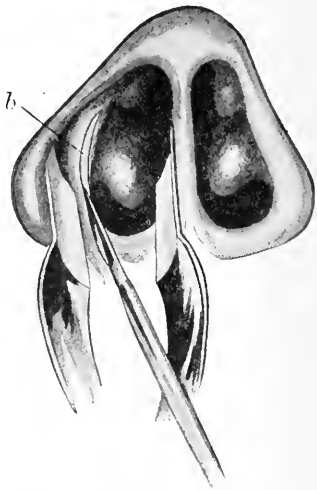


FIG. 329.—Canfield-Ballenger operation: *b*, the incision. (Ballenger.)

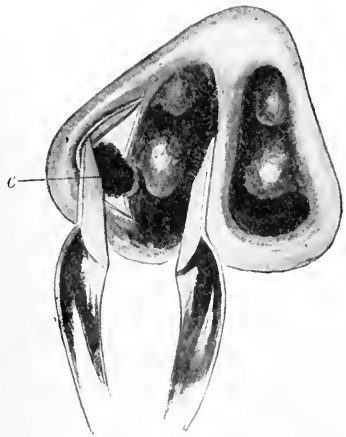


FIG. 330. — Canfield-Ballenger operation: *c*, the naso-antral angle removed, thereby exposing the cavity of the antrum. (Ballenger.)

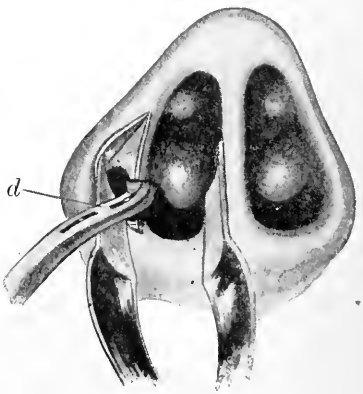


FIG. 331.—Canfield-Ballenger operation: *d*, the naso-antral wall being severed with the Wagener forceps. (Ballenger.)

Canfield-Ballenger Antrum Operation.—This operation is illustrated by Figs. 328, 329, 330, 331 and 332, and is described by Ballenger as follows:

"*Technic.*—Anesthesia: (*a*) Induce anesthesia of the nasal mucous membrane by the local application of cocain or any other drug preferred; (*b*) induce anesthesia of the vestibular skin of the naris by the injection of Schleich's solution. This solution should also be injected beneath the periosteum of the canine fossa *via* the vestibule of the nose.

"*Incision.*—Distend the wing of the nose with a nasal speculum, as shown in Fig. 328, to bring the anterior angle of the naso-antral wall into prominence. Then with a small scalpel make an incision the whole length of the exposed portion of the naso-antral angle (margin of the pyriform aperture, Fig. 329). Then elevate the membrane, including the periosteum over the canine fossa (Fig. 330).

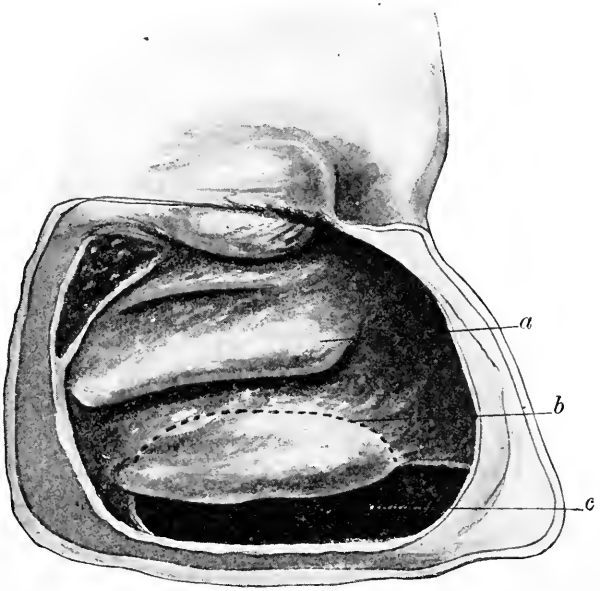


FIG. 332.—Interior view of the Canfield-Ballenger antrum operation: *a*, middle turbinal; *b*, line of attachment of the inferior turbinal, which is left intact; *c*, the naso-antral wall removed, extending from the floor of the nose to the attachment of the inferior turbinal and from the anterior to the posterior limits of the antrum.

"*Opening the Naso-antral Angle.*—The antrum should be opened *via* the naso-antral angle (margopyriformis) with rongeur bone forceps, as shown in Fig. 330, or with a gouge and mallet. In some subjects the bone at this angle is dense, requiring considerable force to bite through it, while in others it is extremely thin and easily removed. While the incision extends higher than the attachment of the inferior turbinal (to allow retraction), the bone at the angles should only be removed below the line of attachment of the inferior turbinated body. In removing the bone constituting the canine fossa, it is usually only necessary to remove enough to admit of the introduction

of the Wagener antrum forceps, as shown in Fig. 331. If, however, after making the opening through the naso-antral angle it is determined that the whole of the mucous membrane is not accessible to the curette, as much of the canine wall may be removed as will fully expose it.

"*Removal of the Naso-antral Wall.*—The biting jaws of the Wagener forceps (Fig. 331) are placed astride the naso-antral wall and the wall bitten away from the attachment of the inferior turbinate body down to the floor (Fig. 332). This makes an opening about one and one-half by five-eighths inches in size. An opening of this size will never close by granulation. It was formerly thought necessary to also remove the anterior half of the inferior turbinate body, to expose the naso-antral wall to surgical interference. By this method it is rendered unnecessary, hence the inferior turbinal is unmolested and is preserved and continues to perform its respiratory functions.

"*Intermediate and After-treatment.*—If the mucous membrane of the antrum is edematous and has not undergone polypoid or granulation degeneration, it is not necessary to curette it away (Myles). When such a pathological condition is present, packing the antrum with gauze moistened with the compound tincture of benzoin daily for three or four days will relieve the edema, and the mucous membrane will resume its normal structure and function. When, however, the mucous membrane is converted into large granulation masses or polypi, it should be thoroughly removed with a sharp curette, thereby denuding the bony walls. If this is done a new mucous membrane will not form, but the walls will become covered with thick fibrous tissue, which partially obliterates the antral cavity. Such tissue does not develop columnar epithelium, but continues to secrete a semipurulent fluid. For this reason, curettage should be avoided unless the pathological condition warrants it.

"After three or four days the gauze dressings should be discontinued. The cavity may then be swabbed or sprayed daily with a 10 per cent. solution of ichthyol to stimulate local hyperemia and leukocytosis (raise the resistance; raise the opsonic index), thereby hastening the reparative process.

"In conclusion, I wish to say that this method of operating is (*a*) radical, inasmuch as it fully exposes the cavity of the antrum to inspection and treatment; (*b*) it is conservative, as it is attended by the least possible destruction of the physiological structures, particularly the inferior turbinal, which is neither temporarily nor permanently resected; (*c*) furthermore, the operation may be done under local anesthesia, whereas other operations equally radical (and more destructive) must be done under general anesthesia; (*d*) the time required for this operation is much less than that for other radical operations."[1]

Comparative Review of the Several Maxillary Sinus Operations.—It should be remembered that many acute diseases of the maxillary

[1] Ballenger: Diseases of the Nose, Throat, and Ear, 1914, 4th ed.

sinus recover without treatment. As the inflammatory symptoms subside and the ostium becomes patent, natural drainage takes place and the excessive and frequently offensive secretion disappears, with ultimate complete resumption of normal function.

Proper treatment of intranasal conditions is required to relieve the acute rhinitis which is a natural associate of acute sinuitis.

In this connection it must be urged that the prime requisite in the treatment of all diseases of the maxillary, as of the other nasal accessory sinuses, is the removal of the first cause of the disease. Any nasal obstruction or intranasal defect which may act as a predisposing factor should receive appropriate treatment.

Operative treatment of the sinus itself therefore should be resorted to only when absolutely required.

Puncture and irrigation through the naso-antral wall is all that is required in many acute cases. When the nature of the case demands other treatment, this, of course, should be given, but radical means should not be employed unless it has been demonstrated that this treatment is insufficient, or when there are indications present which make it apparent at the outset that more extensive opening is necessary.

The *alveolar* and *palatal* points of entrance are objectionable for the reasons stated in the description of these operations.

The *intranasal* operation is usually all-sufficient, and in these cases is by all means the operation of choice.

The reasons why it is not adequate to the requirements of certain cases are that it is not practicable to curette the antrum satisfactorily when it is unusual in size or form and contains granulation tissue, polypi, or diseased bone, requiring complete and thorough removal.

While in most cases a large opening in the naso-antral wall gives sufficiently complete drainage, it is well known that the floor of the antrum is frequently lower than instead of on a level with or higher than the floor of the nose.

Thus the question of perfect drainage is somewhat problematical from this aspect.

The *Caldwell-Luc operation* is quite generally advocated and does give opportunity for access to all parts of the sinus. It has the added advantage which is gained by a large opening through the naso-antral wall, and immediate closure of the opening in the oro-antral wall by sutures. While it may not give as complete freedom from infection by mouth bacteria as is claimed, it certainly reduces the danger in this direction to a minimum. In such cases as are adaptable to this operation the results would unquestionably be more satisfactory than with the Kuster operation.

The author's experience lends support to the opinion that there are occasional conditions in which it is most desirable that the oro-antral opening be maintained for a longer period than that required by the technic of the Caldwell-Luc operation. The intranasal operation is unsatisfactory when conditions are such as to require unob-

structed access to all parts of the sinus, however irregular its shape may be, and more or less long-continued capillary drainage by means of gauze packing. The author believes that in certain cases these are important advantages in the Kuster operation in comparison with the results of the immediate closure of the oro-antral wall as performed in the Caldwell-Luc operation.

For example, one of the author's patients had a history of antral disease extending over a period of approximately fifteen years, during which time many operations of various kinds had been performed with unsatisfactory results. When operated upon, and when the sinus was completely opened, a large black sequestrum of bone, which included almost the entire floor of the sinus, was found. It had evidently been there during all of the fifteen years since an attack of typhoid fever, and by its situation was prevented from exfoliating. The sequestrum, evidently a result of exanthematous necrosis, had remained as a sequel of this disease. As a matter of course it was impossible to relieve this condition by any sort of intranasal operation. It would have been equally inadvisable to close the oro-antral opening in such a case until after the local results of the necrosis had been overcome.

As has already been stated, it has not infrequently happened, in the treatment of the author's patients, that a connection has been found between the maxillary sinus and some extension or cell from the sphenoidal sinus. Under these conditions it seems as though there could be no question as to the value of keeping a maxillary sinus packed with gauze and freely open for a sufficient time to effect a cure of the sphenoidal sinus disease as well as that of the maxillary sinus.

There are some cases also in which it seems to be expedient to continue drainage for the benefit of the ethmoidal cells and the frontal sinus, when through unusual conditions there is a more than ordinarily direct communication for the transmission and continuance of infection.

The *Denker operation* appears to be quite unnecessary, more especially because the Canfield-Ballenger operation seems to give all the advantages of the Denker operation in the way of opening the antrum and securing free access, without the same degree of disadvantageous opportunity for mouth infection.

Whether the loss of bone attachment occasioned by removal of the intervening portion of the bone between the opening of the canine fossa and the naris, as described in both the Denker and Canfield-Ballenger operations, could by any possibility interfere with the function or appearance of the lip or face muscles, through destruction of their point of attachment, the author is not prepared to say. While he is convinced that unusual cases of necrosis or pus formation in closely adjacent extensions from the sphenoidal sinus could be reached only with much difficulty, if at all, through an opening such as that

described for the Canfield-Ballenger operation, yet he feels assured that if these objections are or can be overcome, such an operation would undoubtedly be an improvement over all the others

Operations upon the Maxillary Sinus from the Point of View of the Oral Surgeon.—Strictly speaking, it may be said that the treatment of the maxillary sinuses, in common with the other nasal accessory sinuses, belongs largely to the field of rhinology, except when etiological factors or pathological conditions related to oral diseases exist.

With the acute and other less grave maxillary sinus affections eliminated, the work of the oral surgeon naturally resolves itself into the treatment of pathological conditions of the maxillary antra, which have not yielded, or may not be expected to yield, to intranasal or other methods of treatment, except such as give opportunity for complete radical removal of diseased tissues from every part of the maxillary sinus.

In the author's experience the danger of infection of maxillary antra through an oro-antral opening, by mouth bacteria, is not serious if packing has been properly inserted and renewed with sufficient frequency to protect the sinus until such time as nature has had opportunity to guard the recently curetted surfaces by granulation, and if the antrum is frequently irrigated with normal salt solution or any mildly antiseptic non-irritating preparation. The opportunity for continuous irrigation and drainage in some instances is essentially valuable. In short, cases can be cured in this way that seem to resist every other method of treatment. In making this statement the author is fully aware that in many other cases both the intranasal and the Caldwell-Luc operations may give apparently quite as satisfactory results, with less postoperative treatment.

It naturally happens that the classes of cases which come to the oral surgeon for treatment are such as have resisted other methods, and the great majority of these require more than ordinarily thorough treatment, which precludes the expectations of prompt recovery.

Fig. 324, illustrating a case already described, is another example of the complications that make it advisable not only to have free access to all parts of the maxillary sinus but to have an equally good opportunity for observation of its inner surface and the surrounding parts during postoperative treatment.

In another case, in a man who had had many operations in this country and in Europe during a period of more than five years, a considerable quantity of diseased bone was found in the region of the floor of the sinus. It would undoubtedly have escaped notice at the time of the author's operation, as it did at the time of previous operations, if the wide opening in the oro-antral wall, and the situation disclosed in the course of repeated packing, had not afforded opportunity for the observation and study of actual bone conditions. In this way the real cause of the continuance of the disease was readily discovered, and therefore cure brought about.

A great number of cases in the author's practice could, if necessary, be cited to emphasize the almost incalculable value of this treatment. At the same time he is fully alive to the advantages of other methods in suitable cases.

Foreign Bodies in the Maxillary Sinus.—It is not unusual for foreign bodies to find their way into the maxillary antrum. Teeth or portions of their roots or crowns, or pieces of bone, have often been forced into the sinus in attempted tooth extraction. Drainage tubes, such as the piece of rubber tubing that has already been described with reference to one of the author's cases, tubes of vulcanite and of different kinds of metal, were commonly found in this situation when the use of drainage was generally employed in treatment of these cases. Balls of cotton or strips of gauze and small instruments frequently escape through openings in the antral walls when through misguided surgical treatment they have not been sufficiently enlarged. Pieces of metal and other foreign substances have often been forced through the walls by gunshot or other severe traumatic injuries. Sometimes foreign bodies have remained in this situation, and attempts to cure such cases were necessarily ineffective, until the real cause of continued irritation was discovered and removed.

Symptoms and Diagnosis.—Foreign substances in the maxillary sinus usually cause continued inflammation with excessive or offensive purulent discharge, in accordance with the nature of the substance. In diagnosis, under some circumstances, alteration of the form of the walls might be noticed; as a rule, however, such bodies are best diagnosticated with the Roentgen rays. Under favorable conditions they have been felt and located by probing through the external opening, but this cannot be depended upon in all cases.

Treatment.—The first step toward cure must necessarily be removal of the foreign substance, whatever it may be. Usually this involves a radical operation, but when once the source of irritation has been relieved the treatment of such a sinus is identical with that which would be indicated for any similar pathological affection or lesion.

Infectious Diseases.—Symptoms.—All of the exanthemata and other infectious diseases, such as tuberculosis, syphilis, actinomycosis, etc., are prone to attack the maxillary sinus, because of its double susceptibility through the mucous membrane of the nose and periosteum of the bone.

The symptoms under these circumstances are identical with any other indication of the disease, whatever it may be, in a similar situation.

Treatment.—The treatment of infectious diseases affecting the maxillary sinus resolves itself into an effort to overcome the depleting effect of the disease upon the system, and to relieve the local lesion. For example, syphilis may attack the lining membrane of the sinus by syphilitic ulceration or gummatous formation, or it may bring about syphilitic necrosis with extensive bone destruction. Under all

of these circumstances the first consideration must be the constitutional treatment of the disease and the upbuilding of the patient to increase resistance, supplemented by local measures in the way of direct treatment of the lesion itself. Precisely the same principles must govern the treatment of all other antral affections occurring secondarily to infectious diseases.

Polypi.—Hyperplasia of the mucous membrane in the form of polypi is a common feature of sinuitis with or without pus, and would be treated altogether as a symptom rather than a distinct affection, as the term is commonly used, were it not for the fact that polypi may also be tumors of fibroid, myxomatous or even sarcomatous types. Their symptoms and treatment are included in the descriptions of the sinus diseases and tumors with which they are associated.

Polypi have been held by some writers to be pathognomonic of sinus suppuration; but after careful consideration of the many varying reports, the only point that really seems clear is that their presence or absence is not a matter of great significance except with regard to treatment.

Cysts.—Cysts of the maxillary antrum are not uncommon, and may be formed by the distention of the mucous glands quite similar to mucous cysts in other situations. These may be small or so large as almost or entirely to fill the cavity of the sinus. Upon puncture they are found to contain mucous, mucopus, or serum.

Dentigerous cysts may be so situated as to be partly or entirely within the maxillary sinus.

Dental cysts may form from diseases of the teeth and extend into this sinus, and in the course of their enlargement may encroach upon surrounding parts sufficiently to cause more or less disturbance or even deformity through alteration of the form of the bony walls.

Treatment.—A mucous cyst requires the complete opening of the sinus and removal or obliteration of the cyst wall.

In the treatment of both dentigerous and dental cysts care should be taken to prevent infection of the lining membrane of the antrum, which, although it may be forced into exceedingly small compass, is nevertheless usually found to be intact, and under proper treatment of the cyst, through the external opening, will again be restored to its normal situation and condition.

Cystocele.—It has been claimed that the entire sinus may become encysted under certain conditions through the collection of fluid when the ostium is completely obstructed. Many such cases are reported, but the evidence appears to rest upon the point that when opened the sinus was found to be filled with serous fluid and the ostium closed. But there appears to be an element of doubt in all these cases as to whether the condition was really one of cystocele or an enlarged mucous cyst.

Tumors.—Tumors of the maxillary sinus are nor uncommon. Failure to discover the disease in chronic cases seems to offer a favor-

able opportunity in this situation for the formation of malignant growths. Many of the author's cases of sarcoma and carcinoma began in the maxillary sinus.

The etiology, symptoms, and treatment of neoplasms affecting this region are similar to those described under Tumors.

The necessity for prompt and careful diagnosis, however, cannot be too frequently urged. It is sometimes confusing to differentiate between the gumma of syphilis, distortion of the anterior wall of the sinus from a cyst, or destruction of the bony walls from long-continued suppuration in malignant growths.

It may be said in general terms that when an enlargement in this region is opened with a knife and there is reason to suspect the presence of pus, if none be found then the operator should at once be on guard against syphilis or a neoplasm.

The *x*-rays are sometimes exceedingly helpful in disclosing growths that fill the cavity of the sinus, but are not otherwise discernible. The history of the case and the Wassermann test facilitate the diagnosis of syphilis; but the microscopic findings must be depended upon to determine the benign or malignant character of the growth.

CHAPTER X.

DISEASES, TUMORS, AND MALFORMATIONS OF THE TONGUE.

DISEASES OF THE TONGUE.

Stomatitis.—All forms of stomatitis and nearly all of the diseases of the mucous membrane which have been described (pp. 151 to 191) may appear primarily upon the surface of the tongue, or extend to that organ from other parts in the mouth.

Glossitis.—Inflammation of the tongue may be acute or chronic, circumscribed or diffuse. The so-called strawberry tongue of scarlet fever shows how the appearance of the tongue may become an important diagnostic feature in exanthematous fevers and other infections. Superficial glossitis is also due to local irritations, the effect of drugs, and similar influences, and is evidenced by increased redness and swelling of the papillæ, which alter the surface appearance of this organ.

Furring of the Tongue.—In mild catarrhal conditions of the mucous membrane of the mouth there is constant desquamation of the epithelium. When this takes place actively the cells are retained upon the surface, portions of food and bacteria cling to the masses of desquamated cells, and the result is the whitish or brownish furring of the tongue that is common to many diseases. In more or less chronic cases when this heaping of epithelial cells occurs in localized areas, characteristic irregular patches sometimes result, and to this condition the term *geographical tongue* (see Plate XIX, Fig. 2) has been applied.

Dr. Kirk has shown that when there is an unusual amount of lactic acid in the salivary secretion, whether caused by activity of the lactic acid-producing bacteria concerned in the process of dental caries or otherwise, the mucin of the saliva is precipitated.

Undoubtedly the increased agglutinative power thus acquired by the oral secretions is in a large measure responsible for the accumulations of epithelial cells, bacteria, and food products upon the mucous membrane and particularly upon the tongue surface.

Circumscribed Glossitis.—Circumscribed glossitis is usually due to irritation from the sharp edges of a tooth or root, ill-fitting or otherwise imperfect dental plates or bridge-work, accidental biting of the tongue, burns, pipestems, cigars, the continued application of hot smoke; the nervous mouth habits, however, are among the most important causes, as they are likely to be overlooked. These habits have been referred to in connection with the etiology of other buccal affections.

The tongue naturally seeks any unusual or roughened place about the teeth, imperfect interproximal spaces in which particles of food have lodged between teeth, or the spaces occasioned by loss, and this may easily become a habit leading to both acute and chronic conditions.

Circumscribed lingual inflammatory processes may result in local degenerative conditions with hypertrophy or induration, or if *superficial*, an ulcer may be formed. When the affection penetrates more deeply, a localized abscess sometimes results. These do not differ materially from other abscesses, except when they cause general glossitis.

The pathology, symptoms and treatment of these affections closely resemble those in similar conditions in other tissues.

Chronic Glossitis.—When glossitis, whether superficial or circumscribed, becomes chronic, structural changes may take place, which are quite similar to those of any chronic inflammatory process. When caused by specific forms of infection the characteristic lesions appear. Malignant tumors are prone to develop at the site of such chronic inflammations. These are often difficult to differentiate from benign affections. They usually require the aid of a microscope for diagnosis, but certain forms are occasionally so distinctive that no confirmatory evidence is required (Plate XIX, Fig. 3).

Syphilis.—In syphilis (Plate III, Fig. 1) the primary sore is found upon the tongue in a large proportion of cases, and secondary lesions are also frequent, but leukoplakia (Plate VII, Fig. 2), gumma, and the indurated scar tissue following healed lesions (Plate III, Fig. 1) are not only of common occurrence among patients affected by this disease, but are often particularly difficult to differentiate in diagnosis from neoplasms, tubercular lesions (Plate XIX, Fig. 1), and the results of inflammatory affections of other origin (see Syphilis, p. 107).

Leukoplakia (Plate VII, Fig. 2).—This, it is admitted, may or may not be syphilitic. Tubercular affections are less frequent, but, as may be seen from examination of the illustration shown in Plate XIX, Fig. 1, can sometimes only be diagnosticated by discovery of the bacillus, or recognition of the disease by methods such as have been set forth in the description of this affection (p. 181).

This is also true of syphilis, and the methods indicated for diagnosis of the disease (p. 107) must be depended upon for its recognition rather than the appearance of the lesions.

Diagnosis.—Diagnosis is the all-important feature, because early correction may often prevent the development of serious local conditions, and by leading to the institution of remedial measures when general diseases are involved, much additional benefit may ensue for the reason that these might not otherwise be recognized.

Dentists should make it a rule to inspect carefully the tongue and tooth surfaces of all patients. Thickened or irritated areas upon the

PLATE XIX

FIG. 1

Tubercular Cicatricial Destruction of the Tongue.

FIG. 2

Geographical Tongue.

FIG. 3

Glossitis.

tongue should receive immediate attention. Any rough, sharp, or improperly shaped tooth surface, diseased roots or teeth, or imperfect dental work should be removed, smoothed or otherwise corrected.

Every case in which there are lesions that cannot be accounted for should without delay receive the benefit of all modern diagnostic aids, to determine, if possible, the real cause.

Physicians should be on the lookout for causes of local irritation, and refer such cases, with clearly defined directions, to a competent dentist.

Treatment.—The treatment of all of the foregoing forms of glossitis consists in removal of the cause of irritation, local applications to relieve the lesions, and attention to general underlying factors if necessary.

Phlegmonous Glossitis.—When glossitis becomes diffuse and affects interstitial structures (interstitial glossitis), it may be associated with the production of an excess of connective tissue, or acute parenchymatous inflammation may result (parenchymatous glossitis); suppuration may follow and then the condition is known as phlegmonous glossitis.

Etiology.—This affection may result from extension of the circumscribed inflammatory conditions of the tongue, caused by local irritation, or infection. It may, on the other hand, be secondary to phlegmonous processes in the region of the palatal tonsils, or to Ludwig's angina or other inflammatory lesions affecting the floor of the mouth and surrounding parts.

Erysipelas.—This disease is a somewhat rare but very serious cause of phlegmonous glossitis. Although the mucosa and the uppermost layer of the submucosa are principally affected, sometimes excessive swelling of the tongue is caused, and there is danger because of the likelihood of edema of the glottis.

Foreign Bodies.—Fish-bones and substances of this nature are not infrequently forced into the tongue, but, contrary to expectation, these do not often cause phlegmonous glossitis.

W. Murray[1] reports that $\frac{3}{4} \times \frac{1}{8} \times \frac{1}{4}$ inch of a vulcanite pipestem remained in the mouth of one of his patients eight months before being discovered.

One of the author's patients, who had previously been subjected to the ill-advised use of cocain with electrolysis for the extraction of a tooth late one afternoon, had swelling of the tongue during the same night that almost caused fatal suffocation, which was avoided only by the most energetic treatment.

Symptoms.—In glossitis chiefly confined to the preëpiglottic region, the situation in which local irritations are usually first manifested, the symptoms are those of an acute angina. There is difficulty in swallowing, soreness, perhaps pain, and much discomfort, but no serious danger unless the root of the tongue becomes involved. When

[1] British Med. Jour., January 1, 1910.

this occurs, the swelling may be confined to one side or include the entire organ. The tongue is distended to such an extent that it becomes too large for the mouth, and is sometimes forced between the teeth. The resulting pressure is so great that the floor of the mouth is forced downward, the structures of the pharynx backward, and the soft palate upward. Respiration is thus mechanically interfered with even though there may not be an edema of the glottis.

Under these circumstances patients are obliged to bend their heads back as far as possible in order that air may be drawn through the nose over the back of the tongue. The characteristic position is shown in Fig. 88, p. 169. The face is congested. Movements of the tongue are so curtailed that speech is impossible, and mastication and swallowing almost or entirely prevented. The saliva dribbles from the mouth, and the pressure of the tongue against the teeth causes soreness of its borders and adds materially to the general distress. In the region of the circumvallate papillæ the tongue becomes hard and board-like, and this condition in most cases also extends to the submental and hyoid regions.

Treatment.—There is danger of asphyxia and inspiration pneumonia from the uncontrolled saliva which cannot be swallowed and has a tendency to overflow into the respiratory channels. Being filled with pyogenic microörganisms, bronchial and pneumonic affections are natural consequences. The toxic and septic influences common to all virulent infections are also to be feared.

Treatment must therefore be prompt and energetic in order to be effective. A deep incision with the point of a curved, narrow-bladed bistoury passed back over the tongue, under guard of a finger, introduced just behind the circumvallate papillæ, and carried forward through the body of the tongue, gives free blood-letting and an exit for serum, or pus if present. This usually allows the excessive swelling to subside sufficiently, at least, to give a measure of immediate relief.

If the hemorrhage is excessive the wound is packed with gauze, otherwise it is allowed to remain open until the swelling has subsided and then closed with sutures if necessary. Mildly antiseptic astringent mouth washes should be used constantly to reduce the inflammation and guard against further infection.

Symptoms of suffocation require an immediate tracheotomy, after which other measures for controlling the swelling may be resorted to.

In less severe cases, or whenever the exigencies of the case permit, irrigation with hot solutions, the face being turned upon one side to allow the fluid to run out freely and to flow continuously for a sufficient time, is sometimes beneficial at the onset of the affection, and may abort the progress of the inflammation sufficiently to make more radical measures unnecessary.

Kümmell recommends for cases in which there is a marked induration in the submental region, with the skin red and edematous,

a deep incision extending between the genioglossi muscles and the wound, and enlarged in the substance of the tongue by blunt dissection. He states that:

"The evacuation of the foul-smelling pus always produces an immediate amelioration of the pain and dyspnea. This incision has the advantage, moreover, of a complete evacuation, without the danger of pus and blood finding their way into the air passages."[1]

Gangrene of the Tongue.—Gangrene of the tongue may be due to pressure against the teeth when it is swollen, or to vascular disturbance incident to a phlegmonous glossitis; to severe injuries, burns, noma, Ludwig's angina, and other destructive processes which occur in the course of typhoid, puerperal, and other infections.

Pseudomembranous Glossitis.—This is a rare affection accompanied by marked exfoliation. Sometimes casts of the tongue are exfoliated. The diphtheria bacillus, streptococci, and sometimes pneumococci have been known to give rise to this condition.

Treatment.—Local measures are of little avail. Antistreptococcic serum treatment and helpful measures of a general nature must be relied upon.

Psoriasis.—Psoriasis of the tongue is a term used by some authors synonymously with leukoplakia buccalis.[2]

Nigrities Linguæ.—This disease, also known as black tongue, is a form of hypertrophy of the papillæ of the tongue with pigmentation.

Etiology.—The cause is not known. Dr. Kirk, of Philadelphia, made careful bacterial examinations in an interesting case that came under his care, but without definite identification of a specific bacterium.

Symptoms.—The dorsum becomes covered with a hair-like coating, dark brown or quite black in color.

Treatment.—The only treatment that can be satisfactorily employed without exact knowledge of the cause is a thorough cleansing of the tongue surface and of the mouth generally, the use of dioxogen to aid in freeing the mucous membrane surface from its coating, and general care of the health of the individual.

Nervous Affections of the Tongue.—*Atrophy* of the muscles of the tongue results from bulbar palsy and other forms of muscular dystrophy.

Smooth atrophy of the root of the tongue is characterized by disappearance of the follicles, thinning of the epithelium, and later by muscular atrophy and occlusion of the mucous glands. Some writers have claimed that this is a symptom of syphilis, but it is now known to occur in other diseases such as tuberculosis, senile changes, and other degenerative processes.

Tremor of the tongue is evidence of nervous disease, as is also the *deviation of the tongue to one side,* when protruded from the mouth.

Hemiglossitis.—A transitory, unilateral swelling of the tongue believed to be of nervous origin.

[1] Von Bergmann: System of Practical Surgery, i, 839, 840.
[2] Dorland: American Medical Dictionary.

Symptoms.—The tongue becomes enlarged upon one side. During the early stages there is acute pain and high fever, which usually subside by the end of the first day and the swelling after three or four days.

Treatment.—Palliative treatment may give a little comfort, but the affection usually runs its course. Nerve tonics, hygiene, and similar aids to general nerve resistance are indicated.

Foot-and-mouth Disease.—Vesicles and painful swelling of the tongue are prominent symptoms. In such cases diagnosis and treatment of this affection as described (p. 161) are required.

Actinomycosis (p. 129), **Glanders** (p. 134), and **Leprosy** (p. 139).—These have tongue lesions which are included in the description of these diseases.

Riga's Disease.—This disease is a sublingual growth in infants. It is essentially an ulcerative or pseudomembranous lesion on the under surface of the tongue which involves the frenum.

Etiology.—It is undoubtedly caused by infection which is presumably influenced by difficulty in eruption of the lower incisor teeth.

Symptoms.—For the greater part it affects nursing infants and begins by an ulcerative or necrotic process, which is followed by a granulomatous growth that sometimes closely resembles papilloma or fibroma.

Treatment.—On account of the susceptibility of infants, the local treatment must be such as can safely be applied to inflammation in an infant's mouth.

Careful examination of the erupting teeth should be made and inflammatory processes relieved by incisions through the gum over their crowns if necessary. If digestive disturbance is evident, corrective measures must be employed.

Myositis.—The various forms of myositis may affect the muscles of the tongue the same as other muscles. Acute conditions are apparent in myositis. The form of acute poliomyositis, called *dermato-mucoso-myositis,* sometimes attacks the tongue, and may be associated with stomatitis with or without ulceration or angina.

Etiology.—This is believed to be caused by infection, but the fact that the condition is sometimes accompanied by polyneuritis lends color to the belief that nervous conditions may also be important in its causation.

Symptoms.—The muscles are swollen, red or pale yellow, sometimes streaked with gray or reddish striæ. In consistency they may be firm or soft and boggy, and are sometimes accompanied by hemorrhages.

TUMORS OF THE TONGUE.

Cysts.—**Varieties.**—*Retention Cysts.*—The retention cysts sometimes found at the tip of the tongue are caused by occlusion of the glands of Blandin-Nuhn. For further description see p. 436.

Hydatid, Echinococcus and Cysticercus Cysts.—Hydatid cysts, echinococcus cysts, and all forms of cysticercus cysts, caused by the scolex or larvæ of tapeworms, have in rare instances been found. They resemble mucous cysts in roundness of form, but are harder, less transparent, can be moved about with the finger and are always multiple. They may be distinguished from mucous cysts by these features (see p. 435).

Dermoid cysts are sometimes situated between the genioglossi and extend into the body of the tongue (Fig. 333). The detailed consideration of dermoids may be found on p. 442.

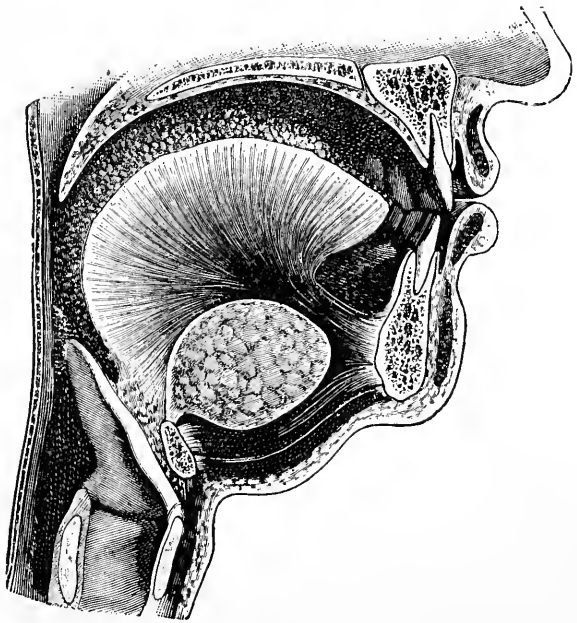


FIG. 333.—Dermoid (ad-hyoid) cyst at base of tongue. (Marchant.)

Treatment.—The removal of a dermoid cyst at the base of the tongue, as shown in Fig. 333, requires an incision in the median line from the chin to the hyoid bone. Division of the tissues is made down to and between the geniohyoglossi muscle and retraction effected to expose the tumor, which is freed by blunt dissection. This is comparatively easy to accomplish unless the cyst walls are bound by inflammatory adhesions. Great care must be used to avoid, if possible, rupture of the cyst wall. After removal of the cyst the wound is packed with gauze, if necessary to control hemorrhage. Otherwise drainage is inserted and the wounds closed.

Cysts at the Base of Tongue.—Cysts at the base of the tongue are sometimes found occupying the sinus pyriformis.

Etiology.—These cysts are apparently caused by remains of the fetal thyroglossal duct.

Symptoms.—They seldom give much disturbance. The symptoms are usually quite similar to hypertrophy of the lingual tonsils. Reflex cough and a sense of discomfort such as might be caused by any foreign substance in the throat may occasion annoyance (Fig. 334).

Diagnosis.—A laryngeal mirror facilitates diagnosis.

Treatment.—Incision and cauterization will usually accomplish their removal.

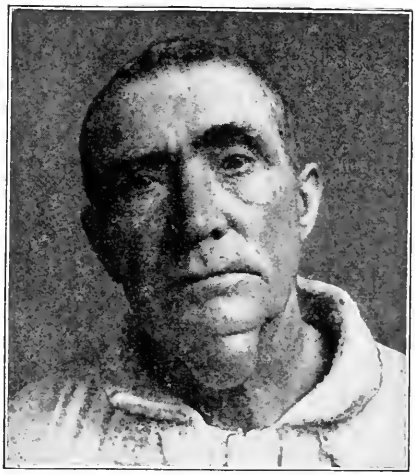


FIG. 334.—Thyroglossal cyst. (Brewer.)

A. S. Taylor[1] reports the following interesting case of cyst of the thyroglossal duct:

"A man, aged forty years, for three years had had a cyst just above the larynx, which gradually became more annoying, so he had to have it removed. A transverse incision was made over the cyst, which extended from the upper border of the larynx to the under surface of the hyoid. From this point a small fistulous opening penetrated the hyoid and extended to the base of the tongue. The growth was shaped somewhat like an Indian club above the hyoid and ran up to the dorsum of the tongue. The cyst below the hyoid had pushed the thyrohyoid membrane back until it almost touched the wall of the pharynx. Although the patient is a singer, this has not interfered with his voice. The cyst was entirely removed: no drainage was used; primary union."

Lipoma.—Lipoma of the tongue is exceedingly rare, although such tumors have been found in this situation more frequently than in other parts of the mouth. It is believed that in a considerable portion of these cases the condition is congenital.

[1] Ann. Surg., February, 1910.

Papilloma and Fibroma (see pp. 450 and 460).—These tumors are sometimes found upon the dorsum of the tongue. As they are painless and of slow growth, their chief significance lies in the likelihood of their becoming malignant, or in the course of slow development giving more or less serious inconvenience. Their removal when required may usually be easily effected, and the same rules apply as for the treatment of similar growths in other parts.

Adenoma.—For general description, see p. 452.

Lingual Goiter.—So-called accessory thyroids at the base of the tongue are tumors consisting of tissue derived from the thyroid gland, which until recently have been described as adenomata.

The suprahyoid glands are remnants of the imperfect middle lobe of the thyroid gland. They are found embedded in the substance of the tongue where the thyroglossal duct empties at the foramen cecum. The accessory thyroids usually found in females are situated farther down near the hyoid bone.

Ectopic or supernumerary thyroids may also be found in the base of the tongue.

These tumors are now recognized as aberrant goiters.

Etiology.—They originate from the remnants of the median thyroid outgrowth or an ectopic thyroid embodied in the base of the tongue. Histologically they are similar to other varieties of goiter.

Symptoms.—These strumous growths are situated in the median line. They form a round swelling behind the circumvallate papillæ; are covered with smooth mucosa or have slightly notched surfaces; are elastic and quite vascular; numerous veins may be seen coursing over the surface of the thin mucosa; they seldom or never ulcerate, but do often cause hemorrhages; their growth may be so slow that the swelling may pass unnoticed; it may be continuous or progress to a certain point and become stationary; or may change to an acute condition in which increase in size takes place rapidly. These tumors are painless, but may become so large as to interfere with speech, deglutition, and respiration.

According to M. Leulier,[1] "Myxedema seems to be unusually frequent in these goiters, and assumes all forms from idiocy to early perceptible symptoms."

Diagnosis.—Differentiation must be made from malignant disease of the glands. Thyroglossal duct cysts from dermoids, ranula, lingual tonsils, and angiomas. Slowness of growth usually excludes malignancy. Angioma is more spongy, more irregular in outline, of a purple color, and usually showing venous extension to one of the lateral pharyngeal areas.

Treatment.—The extirpation of these tumors is required if the functional disturbance is sufficient to make their removal imperative. If a thyroid is normal, complete removal is indicated. When the

[1] Thése de Paris, quoted in Presse Médicale, May 18, 1918.

thyroid is abnormal and there are signs of myxedema, a portion of the thyroid tissue of the tumor should be left, to prevent cachexia.

The removal of these growths may be performed through the mouth after preliminary tracheotomy and tapping of the trachea. The tongue is drawn forward with ligatures and the growth removed. Wolf recommends temporary resection of the maxilla for infants. It would seem as though this might be the safer procedure in cases with tendency to severe hemorrhage.

Charles Mayo[1] gives the following operative description:

"In the enucleation of lingual thyroids the tongue and pharyngeal areas are cocainized, the patient anesthetized with ether and a rapid operation made while the tongue is held in extreme tension. The free hemorrhage is controlled by deep sutures. In very extensive superior lingual goiter it may be advisable occasionally to ligate the lingual arteries and make a laryngotomy as a preliminary procedure. It will rarely be necessary to divide and separate the lower jaw.

"While the operations for the removal of lingual thyroids through the mouth have been quite bloody, they have been successful; practically no fatalities have been reported. Although there have been approximately but 50 cases recorded, undoubtedly there have been many others in which patients have been operated on."

Hemangioma.—These growths are congenital, although they may not be noticed until enlargement calls attention to their existence.

Varieties.—*Simple angiomata* appear upon the tongue as bluish-red, elevated patches of variable size, usually about as large as a pea. They may be single or multiple.

Cavernous angioma presents dark blue ridges or masses above the surface of the mucous membrane, and sinks deeply into the submucous tissues. Under pressure the blood in these tumors recedes and immediately returns when pressure is removed. They show more or less increase in size when the patient stoops and are again smaller when the head is erect.

Cavernous angioma sometimes invades surrounding tissue so excessively that almost the entire tongue may become involved. Hemorrhages may occur as the vessel walls become thin and lose resistance.

Treatment.—Small circumscribed angiomata require no treatment other than cauterization, and ordinarily may even be allowed to remain without serious disadvantage.

Cavernous angiomata when very small may be excised under cocaine anesthesia, but tissue outside of the distended vessels should be included to avoid excessive hemorrhage. A somewhat larger angioma may be incised, and the spongy mass thoroughly curetted. To do this the affected tongue area is cocainized and the tongue clamped to prevent excessive bleeding. After pressure is removed, bleeding vessels are ligated. In operations upon very large cavernous angiomata of the

[1] Jour. Am. Med. Assn., September 2, 1911, p. 786.

tongue every precaution against the ill results of hemorrhage must be taken. The pharynx must be packed with gauze and other precautions that have veen described for the management of hemorrhage from mouth operations observed. Ligation of the lingual arteries or even the external maxillary arteries may be necessary.

Thiersch's method of ignipuncture has met with considerable success. He forces a Paquelin cautery into the tumor at several points, thus creating an inflammatory action which tends to cause an obliteration of the growth.

Lymphangioma.—Lymphangiectases are sometimes found on the end of the tongue. They contain a viscid fluid, may attain considerable size, and usually have a base made up of smaller cysts.

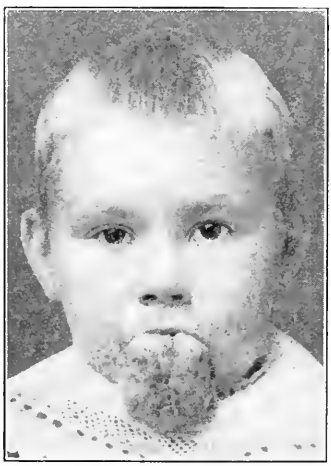


FIG. 335.—Lymphangioma of the tongue—macroglossia. (Westmoreland.)

Nodular lymphangiomata are small, isolated, hemispherical elevations scattered over the base and back of the tongue, singly or in groups. The roughened surface is covered with minute vesicles that contain watery, turbid, or bloody fluid. These lesions have a firm base which has been shown to be an inflammatory product caused by temporary periods, during which the growths are slightly inflamed and enlarged. The induration remains as a permanent result.

One of the author's cases, that of a little boy, aged about three years, showed several small lymphangiomata along the border and anterior third of the tongue, and although it did not seem likely that the small red elevations upon the tongue surface could by any possibility interfere with speech, yet the child could only utter a few words, and these very indistinctly.

Treatment.—Deep cauterization under local anesthesia, repeated at intervals, if necessary, will cause a disappearance of these growths

in the course of time. (See Lymphangioma and Macroglossia, pp. 464 and 543.)

True Cavernous Lymphangioma.—This may lead to enlargement of the tongue, which is one form of macroglossia. The condition exists at birth, but is more noticeable when the tongue has become so large that it projects beyond the teeth and lips. Fig. 335 shows a typical case of lymphangioma of the tongue.

Treatment.—The excision of wedge-shaped pieces to reduce the size of the tongue, and this repeated at intervals, with the removal of a portion of the tip also, if required, will overcome the trouble in the course of time.

Endothelioma.—This tumor rarely affects the tongue.

Sarcoma.—Sarcoma is found more frequently in this situation, but is not common.

Carcinoma.—Carcinoma is unfortunately very prevalent in persons of advanced years. The diagnosis and operative treatment of these growths are described under their several headings, page 474, etc.

MALFORMATIONS OF THE TONGUE.

Aglossia (Congenital Absence of the Tongue).—This deformity is never found with malformations of the face alone. It is assumed that, in common with congenital tongue defects, this is caused by the formation of amniotic bands and adhesions which restrain and interfere with the development of the embryonal fissures.

Bifid Tongue.—Agnathia, the congenital absence of the lower jaw, is always accompanied by absence of the tongue or bifid tongue. Bifid tongue has been found with a case of divided lower jaw. The tongue is sometimes divided as the result of accident or disease, noticeably sclerotic syphilitic glossitis. The natural appearance of the mucous membrane in the former condition as distinguished from the cicatrized surface of the latter, together with the history of the case, makes diagnosis comparatively simple.

Lobulated Tongue.—Congenital clefts in tongues sometimes take the form of lobes projecting out from the body of the tongue. An example of this is shown in Fig. 336, taken from the photograph of the tongue of a little girl, aged five years, who came under the author's care for treatment of congenital cleft palate. It was difficult to determine to what extent the tongue defect was responsible for her inability to speak, because of associated nasal and palatal defects.

Microglossia.—A congenital condition in which the tongue is small enough to warrant this descriptive term is rare, but there are cases in which the tongue is so small as to appear to be almost entirely absent.

A newly born infant that was brought to the author for treatment had a tongue so small that its tip was barely discernible when the mouth was opened.

The base seemed fairly large, and in the belief that some congenital

insufficient development of the glossopharyngei muscles or adherent bands of tissue might be holding the organ back, an attempt was made to cut these muscles and draw the tongue forward to fill its natural place. It was found to be impossible to benefit the child by surgical assistance.

Macroglossia (Megaloglossia) (see Lymphangioma, p. 464).—Enlargement of the tongue also takes place in acromegaly, and its control is subject to general treatment of this affection as described (p. 542) and such operative procedures as may be required to give relief.

FIG. 336.—Lobulated tongue. Child, aged five years.

Long Tongue.—Abnormally long tongues sometimes become a menace through danger of their being swallowed. Cases have been reported in which suffocation has occurred from this cause. Girod reports a case in which the tongue could be extended 7 cm. beyond the line of the incisor teeth. Naturally only the exceedingly long tongues have occasioned sufficient notice to be reported; but the author believes that in certain individual types a long, narrow tongue resembling the tongue of a dog when protruded is not unusual; and in these cases there is very likely to be speech difficulty.

Lingua Plicata or Dissecata.—This is a congenital condition in which the tongue is moderately enlarged and has a number of longitudinal transverse folds. In these cases there is absence of uniform and smooth surface, although the mucous membrane appears to be otherwise unchanged, and the parenchyma retains its soft character.

Treatment is not required in these cases unless enlargement of the dental arches may be indicated or some correction required because of annoyance to the patient.

Ankyloglossia, Lingua Frænata, or Tongue-tie.—This is caused by a large and anteriorly displaced frenum.

Symptoms.—Attention is usually called to the trouble in infants, because they have difficulty in sucking, and upon examination it is found that the tip of the tongue cannot be raised, or is turned downward when the tongue is protruded. Mothers and even attending doctors often overestimate the importance of this condition. In most cases

if the finger can be introduced beneath the tip of the tongue and that organ drawn forward over the alveolar border an incision is not required, and should not be made unless obviously necessary.

Ankyloglossia in greater or lesser degree is sometimes found in older persons, and in these cases decision as to the best procedure is sometimes difficult, as indicated by descriptions of cases which follow.

In many of the author's cases of children past the age for the natural acquirement of speech, and even adults, the difficulty was chiefly noticed because of defective speech. Some of these had had slight but only temporarily effective operations, while the tongues of others were bound with sufficient tightness to interfere with taking nourishment. If there were no other bar to speech progress than the tongue-tie, the diagnosis would be simple, but in many instances there were indications that the individual was to some extent otherwise defective. When in such cases there was a more or less considerable ability to move the tongue, even though contraction at the tip during protrusion showed that it did not have complete freedom, it was hard to say whether defective speech was due to one or the other of the following causes: (1) Entirely to ankyloglossia; (2) primarily to restriction of the tongue and secondarily to failure of development of the speech centers; (3) to inability or reluctance to make the necessary effort to acquire speech, because of the impediment; or (4) to central causes, which would by no means be improved through any sort of tongue operation.

Treatment.—Cutting of the frenum with scissors in infants is a very slight operation; and usually the constant movement of the tongue may be depended upon to prevent the parts from reuniting. As already indicated, operative interference need only be resorted to when there is absolute indication of its necessity.

In the treatment of the older children and adults the operator is confronted with the embarrassing possibility of performing an operation which will not be a benefit if the speech affection be due to some other cause than the tongue condition. In these cases, especially when imperfectly treated in infancy, there is sometimes not alone the actual frenum to be dealt with, but an interweaving of muscular or cicatricial fibers from the frenum along the under surface of the tongue to the tip, which retracts the tip of the tongue during protusion, because development along this surface has not kept pace with the growth of other parts of the organ. In such cases only a plastic operation which will give actual increase in the length of the constricting portion of the tongue might be expected to give sufficient freedom to enable the tip of the tongue to be readily placed in the positions required for correct phonation.

The author's custom in these cases is to direct a course of speech training or other tongue movement for the purpose of demonstrating whether the inability to move the tongue can be improved by training. If the general intelligence and the sense of hearing are such as to permit

improvement in the utterance of the elementary sounds least affected by the tongue condition, then operative procedures are indicated to give the greatest possible freedom in the use of the tongue. Otherwise the surgeon might be subjected to the mortification of performing an operation which could not be beneficial.

Adherent Tongue.—This term is applied when the surface of the tongue and mouth are adherent or bound by bands of tissue. Usually these are attached to the edge of the tongue and inner surface of the lower jaw. Cases have been reported of the tongue being attached to the cheek. In infancy these bands of tissue can easily be broken with the fingers or with a dull, suitably shaped instrument. Occasionally a cut with the scissors may be necessary. Sometimes the anterior portion of the tongue must be dissected free, and the mucous membrane infolded in suturing the wound so that there may be no raw surfaces in contact to cause recurrence of adhesions. The author has done this recently for a boy, eight years old, with very satisfactory speech improvement.

CHAPTER XI.

NASAL DEFORMITIES AND DISEASES IN RELATION TO THE MAXILLÆ.

Etiology.—Developmental Factors.—In the short period between the fertilization of the human ovum and the fifth to the seventh week of embryonic life, examination of the sections through fetal heads discloses that important changes have already taken place. Even at this early stage they are indicative of the principles that must govern the treatment in correction of deformities during the entire period of development of the individual.

"The first pharyngeal arch divides at its anterior extremity into two parts—(*a*) superior and inferior maxillary protuberance. The latter unites very early to its fellow of the opposite side to form the lower jaw. The superior maxillary protuberances are displaced outward and unite to the external nasal process; from this part are developed the internal plate of the pterygoid process, the palate bone, the superior maxillary, and the malar. The lateral masses of the ethmoid, the os unguis, and nasal bones are furnished by the internal nasal process. The rest of these processes on either side are united by a single protuberance, the incisive tubercle, from which the intermaxillary bone and the middle of the upper lip are formed, and according to some the vomer."[1]

It is important to note in Fig. 337, which shows a section through the head of a human embryo at approximately the fifth week, that complete coalescence of the divisions of the forming face and mouth, resulting from progress in this direction of the palatine lamellæ which are given off from the maxillary tuberosities and unite to form the palate, and become joined to the incisive bone to form the anterior part of the mouth and upper lip, has not yet been completed. If, therefore, approximately between the fifth and ninth week of embryonic life, arrest of development interferes, a union in this particular region will not take place. The result of this will be harelip, cleft palate, or both in any of the various forms in which these maldevelopments appear. Reëstablishment of growth in its natural course may and usually does result in the correct formation of other divisions of the head and face, except insofar as they may be influenced by the effect of the disarrangement of muscular and other physiological action through the deformity which has now become established.

[1] Gray's Anatomy.

Inspection of a section through the jaws at this period, under higher magnification, shows the epithelial cord which marks the appearance of the first indication of the tooth germs.

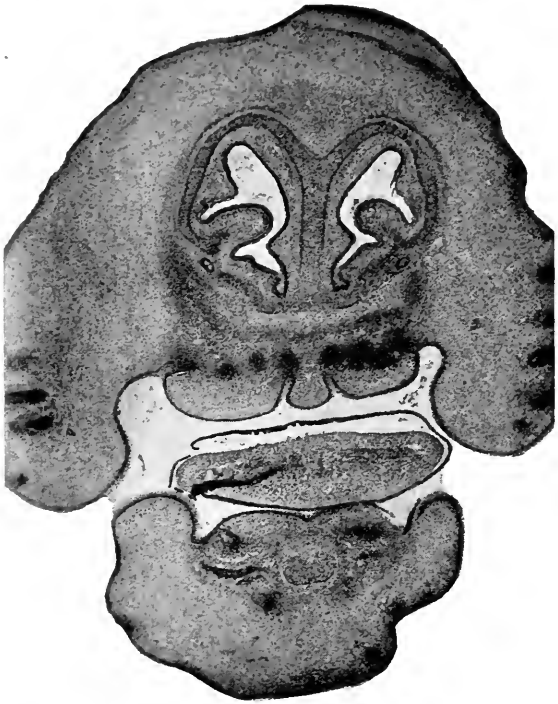


FIG. 337.—Section through the head of a human embryo at approximately the fifth week. (Latham.)

Passing in succession through a series of similar sections (Figs. 338 and 339) at important periods until birth, we find that in the absence of arrest or other interference with normal growth the divisions of the palate become completely united, and the spaces for the nares so much enlarged that they occupy a very considerable portion of the facial division. The palatal surface at this time is flat, because development of the alveolar regions has not yet taken place to any considerable extent.

As the tooth follicles increase in size, and their eruption thus becomes more completely established, some of them are situated high up and just outside the nares. If growth of the alveolar ridges takes place in natural form, unimpeded by any factor which may tend to restrict the natural size of the arch, the developing tooth crowns, the germs for both temporary and permanent sets of which are in place before birth, can pass on downward and outward in the natural course of their eruption. In this way they make it possible for the nares and their

dividing septum, as well as turbinal and other nasal structures, to assume in due course normal form and proportions. When surgical,

FIG. 338.—Section through the head of an embryo at approximately the twelfth week.

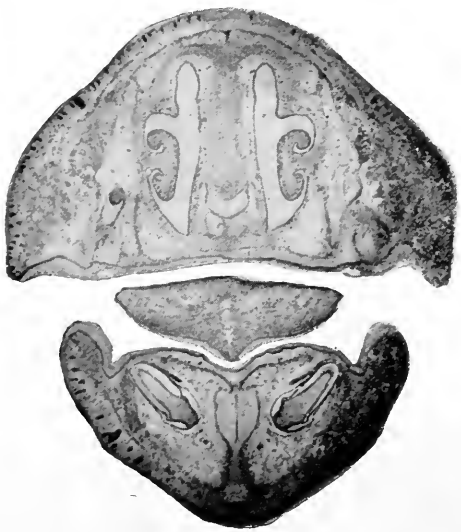


FIG. 339.—Section through the head of a human embryo at approximately the twelfth week. Developing teeth may be seen high up at each side of the nose and beneath the tongue.

mechanical, developmental, or pathological causes interfere with the natural expansion of the arch, which represents the alveolar ridge

and later the dental arch, there naturally must be crowding through lack of space, and the tooth crowns cannot assume their rightful positions in relation to others that are being pushed onward by the forces which cause tooth eruption. The first effect of pressure from crowding must naturally react upon regions of the maxillæ in which the tooth crowns at this time are located. Effort at readjustment takes place in the direction of least resistance. This must be in the direction of the nares, and causes in greater or lesser degree abnormality of form, which is chiefly shown by their restricted size.

The second effect is overlapping of the tooth crowns, evidenced by their eruption on the outside or the inside of the true line of the arch, resulting in labial, buccal, or lingual occlusion. When the process of eruption has continued to a point where the cusps of the teeth in the occluding jaw can come in contact with each other, the muscular forces of jaw movement, acting upon the inclined planes of the cusps and the crown surfaces of the teeth, bring into play the active factors through which regular or irregular forms of dental arches are determined.

Glancing for a moment upon the reverse side of this developmental picture, we must recognize that from the moment of the very first respiration at birth, one of the most potent influences upon which this jaw expansion and development depends is the physiological action of correct respiration. Thus we have established backward and forward an interrelation of growth so evenly balanced that it would seem to preclude its being unusually important to any one division more than the other.

Another interesting feature in the embryonic stages is noticed in the large size of the tongue in proportion to the jaws. This is important in its influence upon the maxillary ridges, and is of great significance. Being so out of proportion in size, arrest in the growth of the jaws consequently fails to give the tongue that space during early childhood which will enable its free use in speech. Such children learn to speak with great difficulty, if at all, or, as might be expected are reluctant to make the unusual effort required of them in learning to form certain words. Thus the brain cells, directing this action, do not develop, and in the course of time such children come to be considered defective, and ultimately really become so, because natural progress of the speech centers is arrested. Undoubtedly many might have been at least approximately normal if there had been correction at a sufficiently early date. In summary of etiological factors pertaining to these affections it may be said that:

1. Any influence which can affect intra-uterine growth, and this includes arrest of development from any cause, be it hereditary, metabolic, incidental, or accidental, can directly bring about or predispose to the malformation of nose and mouth.

2. Any interference with continuous and complete embryonic growth will manifest itself in imperfect form, directly due to the arrested

development and in asymmetrical exaggerations thereof, including alteration in both form and structure by the imperfect physiological action of the immediately affected and surrounding parts.

3. After birth any abnormal muscular activity, whether due to the unusual stress of habit, accident, or other cause, will make its influence manifest in distortion of the form of the growing parts.

4. With obstruction of the upper air passages complete symmetrical formation of the palate and upper maxillary arch cannot, as a rule, be expected.

Conversely, any factor which tends to contract the form of the palate in such a manner as to bring about crowded and high-arched conditions of the palatal vault, with the usually attendant saddle-shaped narrow dental arch, must in greater or lesser degree tend toward contracted nares, deviated nasal septa, and commonly associated nasal defects. For these reasons it is manifest that adenoids and enlarged tonsils, whether first or second in etiological succession, are always and invariably contributing factors of first importance. The propriety of their removal as a corrective measure is obvious. A discussion of the question of etiological precedence may be omitted, since all treatment must resolve itself into procuring increased space for the purpose of more complete physiological action in respiration and also room for development in the dental region.

Treatment of Contracted Nares, Deviated Nasal Septa, and Other Intranasal Deformities by Direct Separation of the Superior Maxillæ through the Median Suture.—As the author has shown in previous writings upon this subject, the appliance he uses for separating the maxillæ is merely an adaptation of well-known orthodontic instruments and principles. The space that appears between the central incisors, which is indicative of division through the median maxillary suture, has been frequently noticed by many dentists and orthodontists, who have had it occur accidentally in the course of their treatment.

His only claim of originality lies, therefore, in the application of these principles for the specific purpose of producing maxillary separation in order that widening of the nares and correction of nasal defects might be the direct result. The surgical operation for the immediate accomplishment of maxillary separation as described and illustrated in this chapter is believed to be new and original with the author. It is undoubtedly true that, having thus obtained the increased size in the dental arch through expansion, the proper space allowed enables Nature to correct many dental irregularities in considerable measure without further interference. Unless locked in lingual, labial, or buccal occlusion, or for some other reason held in malposition by forces or factors which cannot thus be overcome, the natural tendency of all teeth is to seek their rightful positions in the dental arch and to assume proper occlusal relations.

The author has previously estimated that about 75 per cent. of the orthodontia now considered necessary would not be required were

this simple procedure performed at a sufficiently early date. Others have made somewhat higher estimates. Notwithstanding, he wishes it to be clearly understood that this method is in nowise brought forward as a complete substitute for well-known orthodontic systems. It is often necessary to employ the principles and methods of orthodontia to complete what has been accomplished by maxillary separation and to secure permanence for the improved condition by correct occlusion of the teeth in both jaws.

The kind of pressure exerted in the ordinary course of tooth regulation by orthodontists and dentists will not give the increased intranasal space or make possible the correction of nasal defects, in anything like the same degree, even in young children, and in adult cases it is extremely doubtful if any improvement of sufficient value to improve marked deflection of the septum could be secured in any other way than by direct pressure which will cause separation of the maxillary bones.

The reasons for this statement are exceedingly simple. The principles of the various orthodontic systems now in vogue require pressure which will cause a gradual movement of the teeth. The result of pressure so exerted is to cause bone absorption. This Talbot has amply proved.

There are many reasons why slow movement of teeth is advantageous when applied to the correction of dental irregularities.

In order to carry the effect to the higher region of the nose, the less movement of the teeth through the alveolar structures takes place the better the result will be, insofar as widening of the nares is concerned.

For this reason more or less disappointment has sometimes occurred when rhinologists have referred these cases to orthodontists and dentists. Although the teeth may have become beautifully straightened and symmetrical arches secured, the nasal improvement was not such as it might have been had the process of direct pressure here recommended been applied and a positive result obtained within a period of approximately two weeks.

Practical illustrations of the truth of this statement are almost unlimited, and could be multiplied by descriptions of almost innumerable cases in practice during the last few years. The pathological explanation seems to be established with equal certainty when Talbot's experiments on dogs are considered and the author's own results of expansion upon green skulls. Both are here given.

Talbot's experiments with regulating appliances in the mouths of dogs were as follows: The screws, which were given one-fourth, one-half, and one full turn every evening, were 60 threads to the inch. The teeth of the three dogs were moved $\frac{1}{240}$, $\frac{1}{120}$, and $\frac{1}{60}$ of an inch daily, respectively. The process in which the screw was turned one-fourth and one-half turn each day was continued for seven days; the one in which the screw was turned one full turn was continued for

two weeks. The object was to set up pathological changes in the alveolar process similar to those produced in the human mouths. Talbot's findings, proved by microscopic section of jaws of the dogs thus treated, show beyond question that movement under these conditions is effected by the ordinary processes of bone absorption.[1]

The surgical division to which the author's practice is limited, and the constant observation of the marked nasal and maxillary deformities which occur in harelip and cleft palate cases, have impressed upon his mind the fact that there are some principles having a direct bearing upon this subject. Its rationale in nasomaxillary developmental relation can be more accurately observed in those cases than in the course of normal growth, because through the opening in the palate and in the lip the form of the nasal septa affected by normal conditions can be directly studied with the entire field in view. The resulting changes in form and structure of both osseous and cartilaginous nasal structures by adverse muscular action can also be plainly seen.

Although conditions may in many respects be radically different when there are no fissures through the palate or lip, the factors which play a part in determining both intra- and extranasal form results, though modified in degree, are in effect precisely the same. The reader is therefore referred to the illustrations of these cases and the descriptions which accompany them for confirmation of the principles which underlie this method of correcting lesser nasal defects.

The author believes the defects to be accounted for by the double development of the nasal septum which occurs more often than is commonly realized. Not only is the effect noticeable in bulging or buckling on opposite sides of the same septum, but the author has recently had under his care an infant, born with double harelip and cleft palate, in which there was a continuous line of attachment from the nasal septum to the maxillary division of the palate upon each side, the entire central portion being open and apparently not connected with the nares. This condition was discovered in an effort to pass a catheter through the nose for the purpose of continuing anesthesia during the operation for closure of the palate. The catheter, when inserted and passed through the nose, appeared quite close to the Eustachian opening, and could not be passed directly through into the wide open space in the center of the palate (Fig. 340).

The best description of the double development of the anatomical parts of the nasal septum, the nasal processes, the vomer, the vertical plate of the ethmoid, the upper maxillary, the triangular cartilage and its caudal prolongation, and the relation of the premaxillary wings, as affected by developing tooth germs, reflecting upon the form of the septum, has been given with supporting evidence from the anatomical room in an exceedingly complete series of illustrations by Harris Peyton Mosher, of Boston, who states:

[1] Talbot: Interstitial Gingivitis.

"The septum at birth is almost cartilage. The only bony parts are the vomer and the two premaxillæ and their processes. The vomer consists of two leaves of thin bone, which are united below, but are open and flaring above. This formation is a relic of its double origin, evidences of which the vomer never entirely loses. The premaxillary wings spring from the posterior half of the upper face of the premaxillæ. In the groove in which they form rests the tip of the vomer. Two other processes spring from the superior surface of the premaxillæ, namely, the nasal spines. These again make a slight gutter, into which in its turn fits the tip of the premaxillary wings. The tip of the vomer rests in the gutter of the premaxillary wings, and the tip of the premaxillary wing rests in the gutter of the nasal spines, like the arrangements of the sections of the old-fashioned wooden drain. The upper border of the adult vomer is gutter-shaped, like the vomer at birth, the gutter not being so deep.

FIG. 340.—Double development of the nasal septum, with central groove through nose and median fissure of the upper lip and palate.

"A large number of deviations of the septum are caused by asymmetry in the development of the bones which make the hard palate. This inequality of the development is usually due to delayed or irregular eruption of the incisor teeth, especially of the middle incisor. When the eruption of one central incisor is sufficiently belated it causes a deformity or hypertrophy of the maxillary wing above it. This distorts the retaining groove made by the premaxillary wings. As a result the septum slips from its bed in the vomer, and the grooves made by the two leaves of the vomer spread open, one leaf on the side of the vomer disappearing. This produces a spur along the upper edge of the vomer. As the cartilaginous part of the septum slips from its bed the lower edge curls upward and outward, so that its lowest portion becomes concave. Higher up on the septum this concavity gives place to a compensatory convexity. The convexity generally is toward the spur. On the side of the delayed tooth a short basal spur indicates the enlarged premaxillary wing. The upper wisdom tooth may deform the septum posteriorly. This asymmetry shows in the nasal notches anteriorly

and in the choanæ posteriorly and in the mouth. Abundant dissecting-room findings prove that deviations so started may extend far backward on the septum and become obstructive."

It is interesting that this evidently painstaking and exhaustive study of embryonic and later anatomical study, supported by evidence from the dissecting room, coincides so perfectly with the results of our study of maldevelopment and clinical experience in this region. With Mosher's illustrations and descriptions before one, there can be no doubt of the practical corrective efficiency of a method which would separate the halves of these developing parts sufficiently to supply space for their assumption of their normal form, which had been denied them through insufficient room for proper development. The elaboration of the gutter form of the premaxillary wings and vomer, and other evidence submitted shows that with deviations of the septum the first tendency is to slip out of the trough which forms its natural resting place. This makes it plain the reason why straightening of the septum, even in adult patients, takes place in such marked degree when the maxillary bones are separated. This has been proved over and over again in our clinical experience, but there has been some hesitancy about claiming it to the extent which results seemed to warrant, but now the assumption may be that the separation must necessarily reëstablish the gutter form and allow the naturally resilient septum to seek its proper resting place.

Obviously, the simple and most natural method of correction must lie, insofar as possible, in the application of force, which will directly overcome not only the first causes, but the secondary results as well.

The author's appliance, as shown in Fig. 341, is constructed by adjusting metal bands to fit the cuspids and the first or second molar teeth upon each side of the mouth. These are connected by rigid metal bars which rest against the lingual sides of all intervening teeth. To the side bar upon one side a metal tube is attached into which fits a threaded wire extending from the opposite side with a nut adjusted to fit. These are so arranged as to make direct pressure across the palate at the point of greatest constriction when the nut is turned. Force as thus applied is distributed against all of the teeth upon each side of the dental arch, and by turning the nut twice daily, continuing each time until firm pressure is felt but no pain whatever experienced, the maxillæ can be separated through the median suture of the palate and division between the central teeth. When this occurs, the incisor teeth are moved apart, and since the appliance does not touch them in any way, the only explanation is that the bones in which their roots have been embedded have been moved away from each other. Both intra- and extranasal measurements prove that in this movement the nasal bones and other attached parts have also been included, with the result that there is a direct and immediate increase of space within the nares. To prove this definitely, similar appliances were adjusted to green skulls. The result is shown in Figs. 341 and 342, in which the

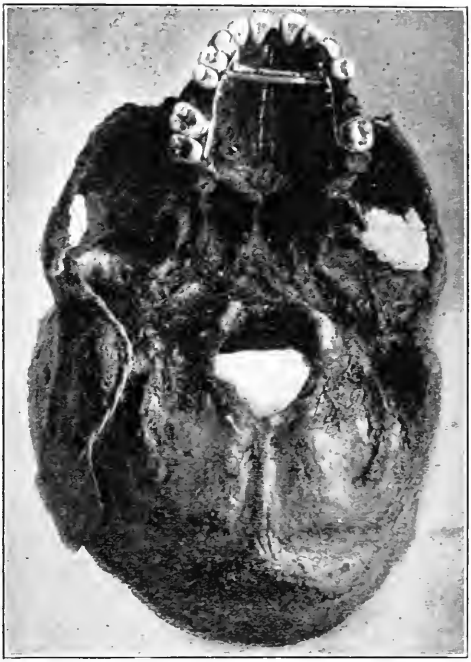


FIG. 341.—Expansion appliance as used by the author in separating the maxillæ to widen the nares.

FIG. 342.—Front view of skull shown in Fig. 341. Division between the maxillary bones up to the nose may be noted.

parted sutures can be plainly noted, with increase in actual measurement of one-eighth of an inch across the base of the nose and one-sixteenth of an inch across the upper third.

When the upper dental arch has been expanded it is obviously necessary to enlarge the lower jaw to correspond in order to secure correct occlusion of the teeth. This can be done without unusual difficulty by orthodontic methods.

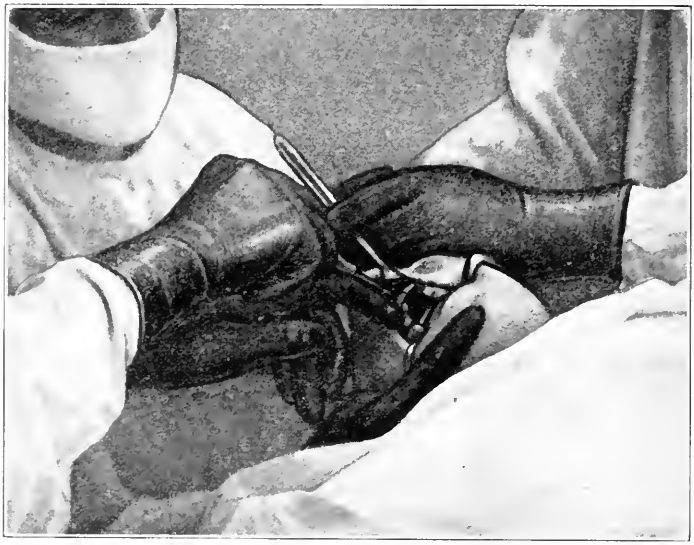


FIG. 343.—Shows splint in place with expansion screw bar across the palate. Vertical incision as made above and between the roots of the central incised teeth down to the bone at the intermaxillary suture.

The Immediate Surgical Separation of the Superior Maxillary Bones to Widen the Nares for the Improvement of Respiratory and Other Conditions According to the Author's Operation.—The day before the operation is performed an expansion splint is cemented to the teeth. This appliance is in all respects the same as previously described for the slower method of rapid maxillary separation, except that additional bands are cemented on both second bicuspid teeth with hooks to slide over the side bars to give greater firmness.

The upper lip is raised and a vertical incision about three-eighths inch long in the median line above and between the roots of the central incisor teeth is carried down to the bone close to the frenum labialis superioris. The periosteum is then slightly raised on each side of the incision and the tissues retracted to expose the intermaxillary suture.

A fine chisel is inserted into the suture at this point, followed with a larger, more wedge-shaped chisel. A few blows with a mallet forces the chisel between the bones and by tightening the screw the separation is made complete (see Fig. 345).

FIG. 344.—Chisel at the intermaxillary suture being driven between the bones by gentle blows with a mallet.

FIG. 345.—Turning the nut on the cross bar of the appliance after the maxillary bones have been partially set free by separation through their intermaxillary and median palatine sutures. The space between the central incisor teeth which are not touched by the appliance indicates the complete accomplishment of the separation of the maxillæ. By turning the nut during the first few days after the operation as much enlargement as necessary may be secured. It is therefore both undesirable and unnecessary to apply much force with the expansion screw during the operation while the patient is unconscious. In this way any possible danger of injury to the teeth is avoided.

In this way the maxillæ are forced apart, carrying with them the attached nasal bones. The result is a direct increase in size of the nares.

The almost instantaneous effect of forcing the maxillæ apart after surgical separation appears to exert a more pronounced influence in the graver types of cases than the slower method of depending upon pressure against the teeth alone as in non-surgical rapid expansion of the upper dental arch.

The freer bone movement thus allowed gives less tendency to flanging of the teeth, and the relation of intranasal enlargement to the increased width across is proportionately improved.

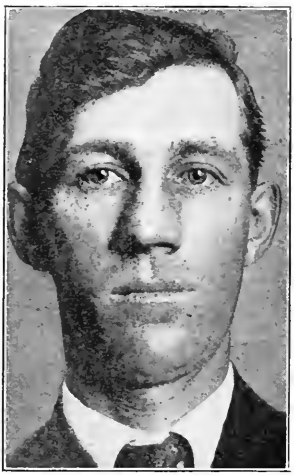


FIG. 346.—Young man, aged twenty-nine years, with nose injured in early youth. Badly buckled septum and almost complete stenosis of one naris.

Clinical Results.—The following cases are fair examples of the usual clinical results. Fig. 346 shows a young man, aged twenty-nine years, whose nose was injured by a baseball in early youth. Dr. Nelson M. Black, by whom the patient was referred to the author, found the septum buckled in such a way as to give almost complete stenosis of one naris, the turbinal bodies much enlarged, and hypertrophic conditions generally marked. The patient was greatly troubled by attacks of sneezing when he bent his head downward. The appliance was adjusted April 6, 1908. Within two weeks the space between the central incisors appeared as shown in Fig. 347. Actual enlargement of the nares was confirmed on examination by Dr. Black, and by the improved breathing experienced on the part of the patient himself, thus proving that even at this patient's age the desired result had been quickly accomplished. Most of the time the patient, who resides in another city, was at a distance from the author, and had the appliance turned by one of the members of his family.

Fig. 348 gives the central measurement with a millimeter gauge of two casts of the mouth of a lad, aged fourteen years, one taken

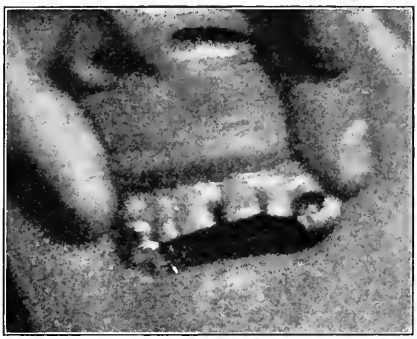


FIG. 347.—Same young man, about ten days later. Separation between the ventral incisors confirmed by intranasal examination, which disclosed enlargement in this region, evidence maxillary separation.

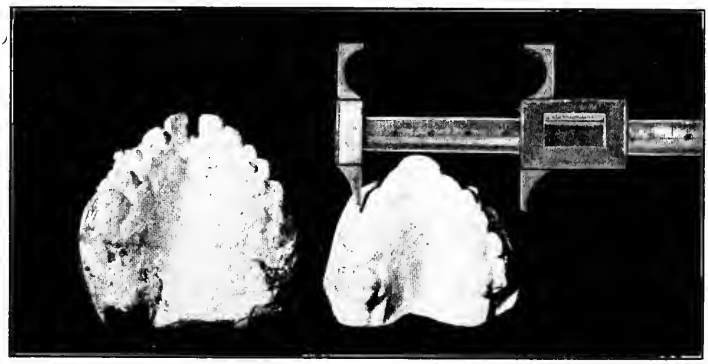


FIG. 348.—Casts of the mouth of a boy, aged fourteen years, before and after expansion. The space between the central incisors closes itself in the course of time without operative influences.

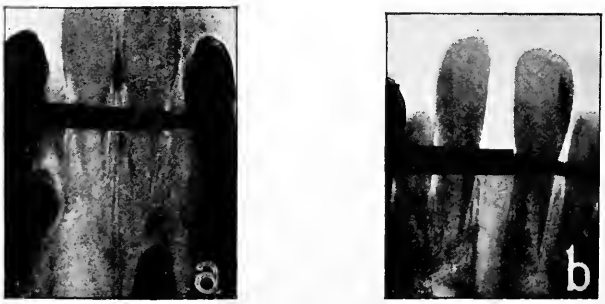


FIG. 349.—Skiagrams of the mouth of a girl, aged eight years. *a*, Showing appliance in place but before pressure has been applied—taken June 29, 1913. *b*, the same mouth July 29, 1913. This result might have been secured much earlier except for delays which occurred by the patient being out of the city.

FIG. 350.—This girl had for years been a great sufferer from bronchial asthma. Her father at forty years of age is still a great sufferer from the same affection. She has been almost entirely free from severe attacks for a long period and although having more or less mild asthmatic disturbance, was able to attend school regularly all last winter. This was impossible before her upper dental arch was expanded and nose enlarged. There is also much improvement in the form of her chest and back. It is confidently believed that she will now entirely outgrow all of these defects.

FIG. 351.—Girl formerly affected by asthma who has been entirely free from attacks since upper maxillary expansion was performed, which warrants the statement that she is entirely cured. Formerly she could not ride behind horses without having severe asthmatic trouble.

FIG. 352.—Tubercular girl with marked scoliosis who is now in good health. Repeated von Pirquet tests negative, although her back will undoubtedly require additional corrective treatment.

FIG. 353.—The same girl shown in Fig. 352. The shape of the face, nose, and chest indicate the necessity of this treatment.

before the arch was separated, the other at the time when the division through the central incisors was evident, and his rhinologist reported sufficient improvement of his nasal condition. This is a fair example

FIG. 354

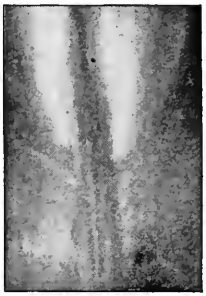


FIG. 355

FIG. 354.—Skiagram of the mouth of a boy, aged twelve years, who was a chronic sufferer from hay fever, headaches, bronchitis, and general nervous conditions, particularly noticeable in winking of the eyelids. Marked improvement in all these symptoms followed widening of his upper dental arch in July, 1912. The skiagram of his palate was taken January 11, 1913. The thick black line along the line of the median palatine suture seems to indicate new bone formation in that region. During these six months his growth in height was increased two and three-quarter inches.

FIG. 355.—Skiagram of the palate of a young man, aged twenty-eight years, for whom wide separation of the median palatine suture was performed, with great benefit to nasal and general pathological conditions; taken two years afterward. The thick dark line shown where new bone had formed in the line of the formerly separated median palatine suture proves that the osteogenetic layer of the palatal periosteum does become active under these conditions and that new bone formation results.

FIG. 356.—The result of traumatic injury. (Wurdeman and Black.)

FIG. 357.—Correction made possible by widening the nares as a preparatory measure. (Wurdeman and Black.)

of the approximate increase in width of the palate that is required in such cases. Figs. 356 and 357 show what may be done by maxillary expansion to prepare for surgical correction of nasal deformity in other respects.

To these, if repetition by citation of other cases were either necessary or advisable, a long list of other patients who have received the same treatment with precisely the same result in the author's practice during the last few years might be added. All show deviation of the nose from the central facial line, an imaginary though clinically a very useful line, taken through center of forehead, tip of nose, and center of chin. Deviation from this line, one way or another, is a fairly certain indication of perverted nasal and maxillary growth, leading almost invariably to pathological conditions.

Especially among growing children treated by this method has there been marked physical improvement, tendency to growth in height, as well as general development and increase in weight. Many had previously been unable to attend school regularly because of the tendency to nose, throat, and bronchial affections. Nervousness was almost invariably very greatly relieved, and this, it is believed, for two reasons: (1) The well-understood results from the improvement in breathing apparatus, with general healthfulness to be expected from better aëration and freedom from diseased nasal secretions; (2) the relief from the crowding together of the dental arches, with tendency to nerve irritation. This condition quite frequently manifests itself, not only in increased nervousness of a general character, but also in the development of neurotic tendencies leading to chorea, epilepsy, and other similar affections. In some instances, at least, these disorders might perhaps have been averted if the patients could have been tided over critical periods in their development. It is a curious fact that even with the disadvantage of having the appliance in their mouths and the bar across the palate, children who are subject to such pathological states almost immediately become less nervous, have increased appetites, and general development goes forward almost from the very first few days after pressure has begun to be exerted.

This treatment might be made a very great factor in safeguarding against tuberculosis. It is so easily accomplished and the results are so greatly beneficial that it should be applied to hundreds of thousands of growing children, who are unquestionably more susceptible to pneumonia and bronchial affections because of imperfect breathing. It offers a possibility of relief which is especially important because such defects are well known to be on the increase, arrested development in the maxillary region being more marked in each generation under the conditions of our so-called civilization.

In the final proof of the foregoing theoretical and clinical conclusions, the author is privileged, through the courtesy of Dr. Lee W. Dean, of the State University of Iowa, to submit to the following record of a young girl, aged seventeen years, a patient of Dr. Dean, for whom maxillary separation was performed to aid the correction of serious nasal and other defects. These measurements were made with an instrument invented by Dr. Dean for the purpose, and taken by his associate, who had no special interest in the case, and whose accuracy

could in nowise be consciously or unconsciously affected by any preconceived idea or expectation. They are therefore absolutely correct.

	A May 28, 1909		B August 11, 1909		C February 18, 1910	
	R.	L.	R.	L.	R.	L.
Anterior end of inferior turbinate to septum	5	6	8	9	9	10
Middle of inferior turbinate to septum	5	4	7	6	7	6
Posterior end of inferior turbinate to septum	10	12	10	12	12	12
Anterior end of middle turbinate to septum	2	2	2	2	4	
Middle of middle turbinate to septum	1	2	2	2	2	1

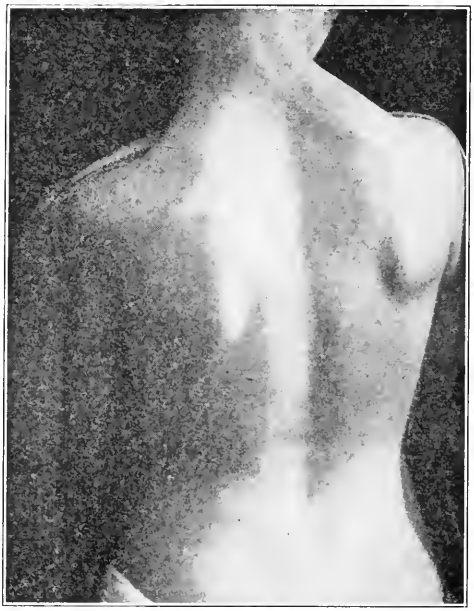


FIG. 358.—Back and shoulder view of a girl, aged fifteen years, with marked spasm of the right side of the face, right arm and right leg. Explosive and slurring speech. Almost total relief from these symptoms was secured in less than thirty days after pressure was applied to spread the upper maxillæ apart to enlarge the nose. Three months later she was so improved that she was able to crochet a pair of silk slippers with a needle held in her right hand which was formerly quite helpless. (Author's article, Ochsner's Surgery, vol. i.)

Having thus fully demonstrated the practicability of the improvement of nasal deformities and attendant disease by separating the maxillary bones and directly increasing the size of the nares, it only remains to prove that constriction or arrest of growth in width across the palate could cause deviated septum, contracted nares, or even complete stenosis.

This the author has been able to do.[1] Several pups eight weeks

[1] Through the courtesy of the Parke, Davis & Co. Laboratory, in whose Biological and Research Department he was permitted to do original work on puppies, with the able assistance of Dr. Ferry and his associates in the laboratory.

FIG. 359.—Same patient shown in Fig. 358. The shape of face and nose gives little indication of her great need of nasal widening.

FIG. 360

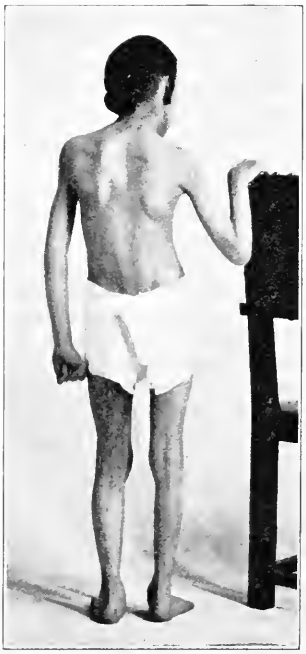


FIG. 361

FIG. 360.—Boy, aged eleven years. Diagnosis: Little's disease. At the time his jaw was expanded he was unable to walk without assistance and had practically no control of his tongue, so that it was almost impossible to understand his attempts at speech satisfactorily, a drooling from his mouth constantly, and other typical symptoms of this affection. He is now able to walk about without assistance and speaks sufficiently well to be understood, can grasp a pencil in one hand and write his name (Sam). No other treatment has been given since his maxillary expansion was performed.

FIG. 361.—Back view of same boy shown in Fig. 360.

old were operated upon by passing a wire through the maxillæ from a point above the roots of the teeth upon one side above the palate and out at a corresponding point upon the opposite side. The palate

FIG. 362.—Control pup. The same age as the one shown in Fig. 363, upon which no operation was performed.

FIG. 363.—Section of head of puppy, aged six months, with jaws arrested in development across the palate by wiring at eight weeks old. These sections show plainly the contracted effect upon the nares, the deviation of the nasal septum, especially the section shown in *C*, the point at which the wire was inserted and development arrested.

was compressed sufficiently to force the upper teeth inside or in lingual occlusion with the lowers, so that the upper and lower jaws of these puppies were placed in about the same occlusal relation that exists in growing children whose bicuspid teeth meet the corresponding lower teeth in lingual (inside) instead of buccal (outside) or normal occlusion. Not nearly so much force in compression was used as would be necessary to close a case of palate fissure according to the method which was formerly widely practised upon infants with cleft palate. The purpose was to reproduce as nearly as possible the maxillary condition of typical cases of mouth-breathing children. One pup was kept without operation as a control, and all were allowed to develop until they reached the age of six months, which, it was estimated, would approximately correspond to the age of a child, aged eight or nine years. The puppies were then killed, the heads frozen, and sections cut through the nose and upper jaws at short intervals. The result is shown in Figs. 362 and 363. Marked difference between the nares will be noted in both series, but the section marked *C* in each is exactly at the point where compression was made. The almost complete stenosis in Fig. 363 contrasts strongly with the same section in Fig. 362.

The laboratory record shows that all of the puppies in this litter, under the same care and with the same food, for a time thrived equally well, and their growth was about the same. During the latter portion of the period, when the effect of the compression upon nasal growth became apparent, the control dog continued to grow and thrive, but those operated upon became emaciated. One died shortly before the expiration of the trial period. The one shown in the illustration was a mere mass of skin and bone. The remaining puppy showed marked congestion of the lungs. The late Dr. Willis S. Anderson, of Detroit, by experiments conducted in the Parke, Davis & Co. Laboratory, produced partial stenosis in dogs by suturing the external nasal openings and by introduction of packings in several ways. He demonstrated that the mucous membrane of the bronchi of dogs in good health is practically immune to pathogenic microörganisms; when breathing is affected, however, it becomes susceptible to every sort of infection. Such dogs become almost entirely hairless, and the puppies of such mothers in some instances lost their hair also.

As is well known, children who are mouth-breathers because of adenoids, enlarged tonsils, or arrested or perverted nasal development, are frequent sufferers from coughs, colds, and other evidences of infectious processes in this region. The same is true with older persons in corresponding degree.

Having thus been able to cause deviated nasal septum and contracted nares by arresting maxillary development, and to correct these deformities and their attendant ills by maxillary separation it seems fair to assume that our case is complete.

With the development of knowledge pertaining to the vegetative nervous system and the far-reaching effect upon physiological and

pathological phenomena that are controlled by the counteracting adjustment of the balance between the sympathetic and vagus systems, much that has hitherto been etiologically and pathologically obscure is rapidly coming to be better understood, and this is particularly true of treatment by jaw expansion.

It is well known that "The vagus system supplies the large glands of the abdominal cavity, the lower two-thirds of the esophagus, the stomach, and the intestines as far as the descending colon. The sympathetic supplies the tract from one end to the other.

"The ganglion cells of the walls of the intestines control this movement of the intestinal organs, but the sympathetic and vagus exercise the regulatory functions of acceleration or inhibition.

"The vagus nerve through its depressor nerve exercises an inhibitory action on the heart, while the sympathetic through its acceleration nerves has acceleration functions. In the digestive tract this is reversed. The vagus accelerates. The sympathetic inhibits."

FIG. 364.—A child, aged eleven years, with chorea and enuresis, winking of the right eye and facial spasm of the right side of the face and nose. Recently operated upon and much improved. Illustrates the type of face with high-arched palate and mouth-breathing for which maxillary separation is demanded.

Higler[1] calls attention to the existence of the following structures, the enumeration of which is important for an intelligent understanding of our present subject. (*a*) Ciliary ganglion lying in the posterior part of the orbit which supplies the sphincter iridid and the ciliary muscle; (*b*) the sphenopalatine ganglia lying on the pterygopalatine fossa which supplies the lacrimal gland and the mucous glands of the nasopharynx; (*c*) the otic ganglia lying under the foramen ovale which

[1] Vegetative Neurology, Journal of Mental and Nervous Diseases: by Heinrick Higler, Warsaw; translation by Walter Max Kraus, New York.

supplies the parotid gland; (*d*) the submaxillary and sublingual ganglia which supply the corresponding glands; (*e*) the automatic ganglia (the

FIG. 365.—Mongolian, aged seventeen years, approximate mentality that of seven years. High, narrow palate and mouth-breathing. Improvement since operation has been evident in this case, but only time can tell in any of these cases how far-reaching the effect may be.

FIG. 366.—Back of same girl shown in Fig. 365.

bulbar part of the vagus domain) which lie in organs and which supply the glands and muscles of the trachea, the heart muscle, and the gastro-intestinal tract from the mouth to the decending colon. (*f*) The ganglion mesentericum inferium, hypogastricum, and hemorrhoidale which lie in the upper and lower parts of the pelvis, supplying the muscles and glands of the descending colon, the sigmoid, the anus, the genital apparatus, and the bloodvessels belonging thereunto.

FIG. 367.—Back of girl, aged fourteen years. The form of the back with the round flabby appearance due to excess of lymphatic tissue is characteristic of the Mongolian type. The distinction may be noted between this and the backs of the opposite types of cases shown in Figs. 352 and 358. Two illustrations of letters written by this girl give indication of her progress after operation; what the future may bring in the way of improvement no one can tell, but her prospects are undoubtedly better than before operation.

With these principles in view it is no longer a matter of wonder that adenoids and enlarged tonsils or any other pathological condition which might tend to inhibit the great areaway of the clearing house of vegetative nervous stimulation in nose, pharynx and bronchi, should go hand in hand with a typical cast of countenance, with tendency to colds, bronchitis and asthma; with dulness of comprehension, lack of concentration and apathy where active bodily and mental vigor is required and in other cases the opposite condition of extreme nervousness; constant desire to overdo in the school, or other mental pursuits; poor circulation, irregular or very rapid heart action, insufficient chest development, spinal curvatures, choreic and other muscular derangments, etc.

It also becomes plain that the reason why tonsillectomy and adenoidectomy, resections of the nasal septum, and temporarily at least even turbinectomy have given such markedly beneficial results in so many of these cases is precisely because of the effect of better respiration upon the controlling balance of this nervous and ganglionic interrelationship. In this light also the effectiveness of a surgical measure which gives a still greater corrective influence by immediate enlargement of both nares and a corresponding increase of the volume of air at each respiration is readily understood.

The endocrine organ activities are undoubtedly important factors in the improvement of these cases as formerly believed, but it now seems probable that they are really secondary to the stimulation of underlying nervous influences which control all the ganglionic and glandular structures. It has been demonstrated by Anderson and also by the author's experiments that interference with respiration by occlusion of the nares from any cause invariably affects the adrenals. Relief in this direction by improved respiratory conditions combined with better vagus control, easily accounts for the marked improvement in the nervous muscular control, coördination, spasmodic affections, enuresis, nervous speech defects, and other similar conditions that have been so uniformly benefited. The application of all these principles and this method as a means of opening the door toward constructive upward progress for subnormal and even mentally defective children, presents a wide field for investigation and study which the author believes gives great promise for the future, when better classification may bring better recognition and selection of cases. Figs. 365 and 367 illustrate types of children who have been greatly benefited in this way.

The following case illustrates these possibilities:

May 12, 1914. Aged eleven years. Previous diagnosis: idiot.

History.—Premature birth. Slow development. Unable to sit until between two and three years old. Began to talk when three years old. Began to walk about four years old. Unable to sleep well at any time. Mother often saw sunrise while trying to put this child to sleep. Eyes were prominent; restless and foolish in expression. Coördination not bad except for the erratic nature of all movements. Speech: strained nervous tone with defective sounds due to imperfect nervous muscular control. Capable of learning some things quickly, but want of concentration and self-control made teaching almost impossible. Effect of maxillary expansion: appliance inserted May 18, 1914.

Report January 20, 1916.—Enuresis completely overcome during the last two months. Appliance off about one and one-half months and no return of old symptoms.

Wide separation of incisor teeth, with corresponding nasal enlargement—the loud stertorous breathing when asleep ceased as regular nasal breathing was accomplished.

Among the early noticeable effects was the changed appearance

of the eyes. Mother without suggestion from anyone asked, "Do I imagine it or have my daughter's eyes changed?" The expression became quieter, the eyeballs steadier and less prominent in appearance, and the staring, foolish look disappeared in marked degree.

She was able to sleep soundly not only at night, but took a long, refreshing, restful sleep every day in addition to regular sleep at night. Better digestion was soon followed by marked growth and improved general appearance. When school opened in September she was so much quieter and under such good control that it was possible for her to attend classes. Her concentration was then such that she could take piano lessons for one hour at a time, and was willing to continue longer if desirable.

The following year she was sent to a private school and her progress has been gratifying.

CHAPTER XII.

MALFORMATIONS, DISEASES, AND INJURIES OF THE LIPS.

MALFORMATIONS OF THE LIPS.

In perversion of fetal development, closure of the fissure that enters into the formation of the mouth may cause absence of the mouth opening, *astomia,* of partially obliterated mouth opening, the result being *microstomia,* or unduly small mouth.

Failure to close to the usual degree leads to *macrostomia,* or abnormally large mouth.

Fig. 368.—Macrocheilia.

Accidental injuries, cicatricial contractions resulting from destructive lesions, surgical operations, and similar agencies may cause complete closure of the opening of the mouth. Its size may be similarly reduced or enlarged to such an extent as to require operative correction.

Macrocheilia denotes abnormal or excessive size of the lips. Lymphangioma of the lips is the usual cause, but it sometimes occurs in cretinism, and under certain conditions of abnormal trophic changes (see p. 317). Figs. 368, 369 and 370 are photographs of some of the author's cases of macrocheilia which present interesting diagnostic features. Fig. 371, showing angioma of the lip, is given to facilitate comparison of these two affections.

Labial ectropion and deficiency of vermilion border may be congenital, or these defects may occur in many ways.

The author's experience in operations upon the opening of the mouth and lips leads him to believe that little could be gained by detailed description of the different operations recommended for stomatoplasty (plastic surgery of the mouth). In actual experience he has found that there is too great variance in the conditions and requirements of such cases to warrant reliance upon any single method. The principles upon which both selection of method and operative technic must depend are included in the descriptions of operations upon the lips and restorations of the oral opening following operations for the removal of malignant growths in the region of the mouth, as elsewhere described (p. 485).

FIG. 369.—Lymphangioma of the upper lip.

FIG. 370. — Lymphangioma of the upper lip. (Another view of same girl shown in Fig. 369.)

Fissures of the Face, Lower Lip, and Lower Jaw.—Lip fissures are sometimes associated with clefts that extend more or less obliquely through the face (Fig. 372).

Fissure through the lower lip and jaw is rare, but sometimes occurs in the region of the first branchial arch. It is due to failure of union in the two inferior maxillary arches. It may be simply a fissure in the lower lip or extend completely through the lower jaw also.

Clefts of the face and jaw occur too infrequently, and the lives of infants with extensive clefts are usually too short to warrant an attempt to outline a proper treatment of such cases. If such an infant were endowed with sufficient life to continue its existence, operative procedures might be indicated and would necessarily be undertaken

to correct the deformity in such form as it might appear; but clefts of the upper lip and palate occur so frequently, and so much is at stake in the restoration of appearance and speech power, that the subject of their correction is worthy of most careful consideration. The subjects are so interwoven that it seems best to treat them together in a separate chapter.

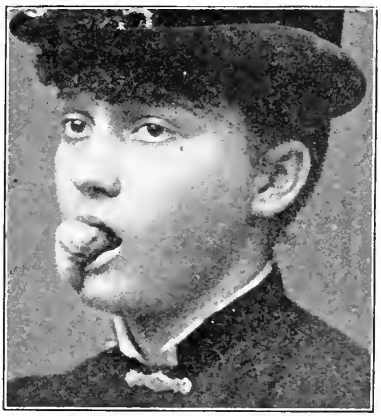


FIG. 371.—Angioma of the upper lip. (Westmoreland.)

FIG. 372.—Complete bilateral fissure (coloboma) of face. (Guersant.)

Diseases affecting the mucous membrane (see p. 151) affect the prolabium, and diseases of the skin may manifest themselves upon the surface of the lips. These insofar as they directly concern our subject have been described in other chapters.

CHAPTER XIII.

HARELIP, CLEFT PALATE, AND DEFECTS OF SPEECH.

HARELIP AND CLEFT PALATE.

Classification.—In classification of these cases three principal divisions require recognition, because they govern operative procedures and results. These are the character of the deformity, its form, and the age of the patient. They are considered in the following classification:

Character.—(*a*) Congenital; (*b*) acquired.

Form.—(*a*) Fissure in velum palati only; (*b*) fissure of the velum, including part of the hard palate also; (*c*) cleft entirely through both hard and soft palates; (*d*) median fissures through both hard and soft palates, with bifurcation at the premaxilla; (*e*) double separation divided by the vomer, including the hard palate, with wide fissure almost completely obliterating the velum.

Age.—(*a*) At birth or during early infancy; (*b*) six months to one year old; (*c*) two years old and during the period after deciduous teeth have been erupted, but before their permanent successors have caused them to loosen; (*d*) twelve to eighteen years of age, or later years, after permanent teeth have been erupted, but before developmental processes have been completed; (*e*) adults with teeth in upper jaws; (*f*) adults with edentulous upper jaws.

Either lip or palate may be imperfect without the other being affected, although, as will be noted by study of the illustrations, it is common for certain forms of lip and palate deformities to be associated.

Congenital harelip deformities are usually either unilateral (see Figs. 373, 375, 377, 379 and 381) or bilateral (see Figs. 394 to 410), although median fissures like that shown in Fig. 340, p. 553, sometimes occur. The fissures may be of first degree, or little more than a notch; of second degree, with a fissure extending completely through both lip and maxillary bones; or of third degree, a wider separation with unilateral protrusion of the intermaxillary bone.

Bilateral or double harelip has usually marked deformity of the vomer with protrusion of the premaxilla. To these must be added the cases that have been imperfectly operated on in early life. These often call for correction, and, although presenting an indefinite variety of imperfections, they have nevertheless certain characteristic defects that admit of distinct recognition, and may be enumerated as follows: (1) Notch at the labial border; (2) deflection of the tip of the nose, with deviation of the cartilaginous septum and flatness of the ala on the affected side; (3) unsightly scars; (4) stenosis of one or both

nares; (5) marked arrest of development due to removal of the premaxillary portion of the jaw; (6) lip too long, and drawn under the incisor teeth, so that it sometimes is between the teeth when the jaws are closed.

FIG. 373.—Single harelip (first degree). Very slight defect without cleft palate.

FIG. 374.—The same child as shown in Fig. 373 after operation.

FIG. 375.—Harelip (first degree). This child had fissure of the velum, but the hard palate was almost complete.

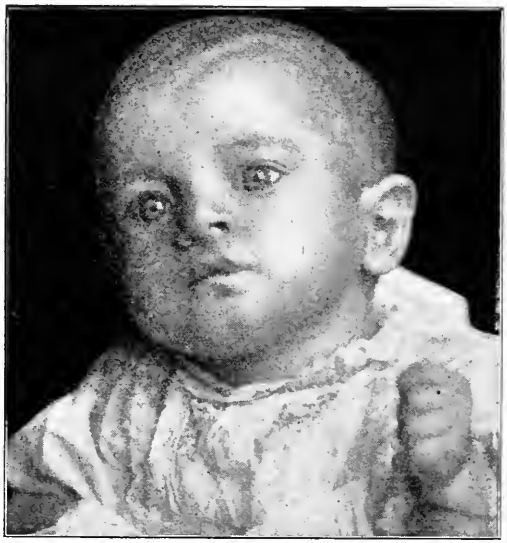


FIG. 376.—Same child shown in Fig. 375 after both lip and palate fissure have been closed by operations.

Etiology.—The chief recognized etiological factors in harelip and cleft palate deformities are direct heredity and hereditary tendency, metabolism, maternal impressions and position *in utero*, and patho-

logical affections of the female generative organs which may affect the form of the ovum.

FIG. 377.—Harelip (second degree). The fissure in this case extended through both hard and soft palates.

FIG. 378.—The child shown in Fig. 377 after operations. Both lip and palate fissures have been closed.

FIG. 379.—Infant with single harelip (third degree) and wide fissure through both hard and soft palates, showing characteristic deformity of nose and mouth.

FIG. 380.—Same baby at eight months, after lip and hard palate have been closed as described.

Direct Heredity.—Direct heredity plays a part in the general resemblance of the offspring to its more or less immediate ancestors, and

also in the transmission through various members of the same family of peculiar deformities or other variations from so-called normal types of both form and mental characteristics, but this fact is not so generally apparent as was formerly believed. The author's records of a very large number of cases with family history, so far as could be secured through three generations, show approximately 10 per cent. of harelip and cleft palate cases in which one or more individuals in the same family had similar defects, either in the present or a previous generation. That there is some greater law governing development and maldevelopment is apparent.

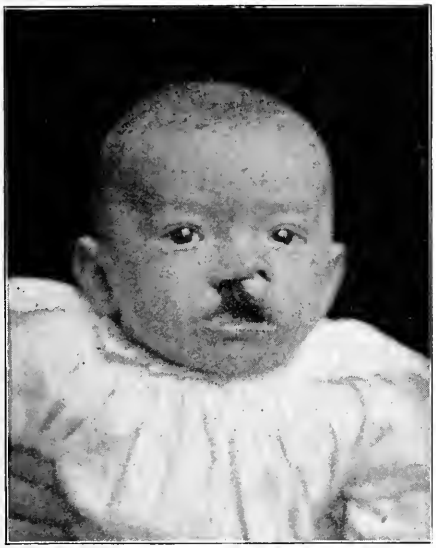


FIG. 381.—Harelip (third degree). Wide fissure through both hard and soft palates.

FIG. 382.—The same child shown in Fig. 381 after operation upon the lip.

Hereditary Tendency.—This includes a very much larger group, as indicated by maldevelopment in form and predisposition to disease through imperfect cell activity.

Maternal Impressions.—There is reason to believe that maternal influences may effect the unborn child, but absolutely authentic cases in which this cause might be the true etiological factor appear to be comparatively few. The author's records, which seem to agree with the records of nearly all others, show almost invariably that the accident or occurrence which was alleged to have frightened or impressed the mother's mind during pregnancy, and thus "marked" the baby, upon investigation was found to have occurred much later than would make the production of this particular deformity possible.

Metabolism.—This is always an important influence, though its significance depends upon its being subject to or in precedence of other factors.

Position of Child in Utero.—The theory of abnormal crowding forward of the head, preventing union of the parts at an early stage of development, appears to be difficult of exact proof.

FIG. 383.—Harelip and cleft palate with unusual deflection of the septum for a case in which the fissures were not wide.

FIG. 384.—Same baby as in Fig. 383 after operation on lip.

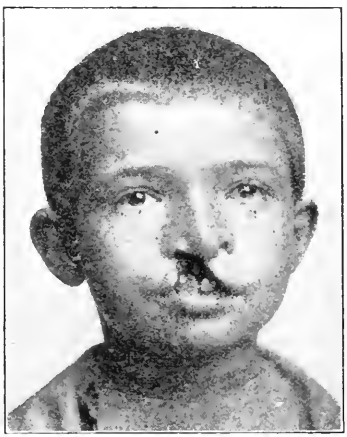


FIG. 385.—Boy, aged fourteen years, with harelip and cleft palate. Shows the increase of the deformity that occurs when such cases are neglected until advanced stage.

FIG. 386.—The same boy as in Fig. 385 after both lip and palate have been closed.

Family Histories.—In the majority of cases the family histories upon one side or the other, and sometimes both, disclose in direct line

of descent, diseases, deformities, mental states, or peculiarities that are now recognized as indications of unstable nervous systems. Many have a neurotic tendency; all betray unequal cell distribution either in peculiar mental or nervous habit, or asymmetrical bodily development. Consanguinity is undoubtedly important when marriage between closely related individuals is shown by the family histories of these infants.

The Hypophysis.—The pituitary body and particularly its glandular portion, the hypophysis, appears to bear a more or less important relation to this and other deformities. It has been demonstrated in many ways that this body exerts an influence over body growth and the related structures; other endocrine organs undoubtedly share in developmental control.

Pathological Affections of the Female Generative Organs.—Prof. Bardeen, of the University of Wisconsin, has called attention to the effect of deforming the ova in causing monstrosities or lesser deformities in animals. He has suggested that any misplacement, defective form, or inflammation of the uterus or its appendages, that might cause the human ovum to be compressed or otherwise distorted, may cause deformity of the child.

Early Treatment of Infants.—From the very hour of birth the question of the manner of treatment of these infants becomes all-important. There is immediate necessity for determining whether early radical operation for closure of the palate first and lip afterward shall be followed, or whether more conservative methods will yield greater safety and better results; upon this decision rests for good or ill the entire life experience of the individual. The author is convinced that radical operation for the purpose of closure of palate fissure in early infancy by immediate forcing together of the maxillary bones is exceedingly harmful and unnecessarily dangerous. It leads to imperfect future results which appear in both defective speech and facial deformity. This opinion is based upon the observation at different ages of a very large number of cases which have received this early treatment. The author's system, to the perfection of which he has devoted many years, is designed to accomplish, by gradual steps the readjustment of the malformed facial features and the closure of both hard and soft palates sufficiently early to prevent the formation of imperfect speech habits. The results of this treatment are shown in the form of actual photographs of individual cases, not in drawings. These have been chosen to represent the types of congenital deformities and defects due to ill-devised operative procedures, with a view also to avoid unnecessary repetition.

Claims of Advocates of Early Operation Harmful.—The author does not agree with the writers who favor early operations upon infants' palates. They claim that the most desirable time for operation is within three months after birth, and that there is less nervous shock because the nervous system of the child is not well developed and the

child is not capable of receiving the same impressions that it would later in life. This is in a measure true, but other adverse conditions incidental to palate operations often more than counter-balance purely

FIG. 387.—Infant with very wide fissure through lip and hard and soft palates, also marked nasal deformity.

FIG. 388.—Same child as shown in Fig. 387 at four years of age after the lip and palate operations have been completed. The final operation was performed when she was two years old. Tendency toward correct development may be noted.

nervous considerations in newborn children. Likewise, he does not believe that in such cases the bony and soft tissues develop naturally according to accepted types and thus allow speech to follow when the

child reaches speaking age. The reasons why he considers such statements erroneous and harmful are as follows:

Estimates of Early Infant Mortality under Operation Misleading.—While it is admitted that during the first few days after birth, before the nervous mechanism has had time to become sufficiently organized to transmit pain acutely, little or no anesthetic is necessary, and that a newly born infant does sustain operation fairly well under some circumstances. At the same time it must be remembered that estimates of mortality in early operation must necessarily be misleading. Many infants do not live beyond the periods of infancy, many die from inanition in spite of good care and carefully selected nourishment, even though no surgical operation be attempted, and it is hardly reasonable to suppose the percentage of fatalities would be decreased by the addition of a surgical operation in every case.

In the development of the human embryo there is coincident development of other parts at the stage which determines the form and character of lip and palate. Causes which lead to arrest of development in this particular region frequently cause arrest of development in other parts of the individual. Many infants placed under the author's care or brought to his notice have had additional fingers or thumbs, or they have been totally deaf from birth, or otherwise defective. Internal defects are manifested in low vitality. One or more of the organs of the body may be unable to perform natural functions with sufficient energy to sustain life, and this is entirely exclusive of the difficulty in taking nourishment, which can be temporarily overcome by the application of strips as described (p. 592), or operation.

Susceptibility to Toxemias in Infancy.—The total deaths in the city of Chicago during one year was 27,212; of these, 5631 were under one year, or more than one-fifth of the whole number of deaths of all ages and from every cause.

Certainly grave surgical operations during the first few weeks or even months would not have reduced this number of infant deaths. Eminent investigators have amply proved that there is a vastly greater resistance to disease and injury of every kind after one year than previously.

Order of Closing Lip and Palate when Both are Involved.—It may be in a measure true that with lip fissure open operation may be more easily performed upon the palate, but no one accustomed to operate in this field has serious difficulty in securing all the space necessary for rapid use of suitable instruments in cleft palate operation after the lip has been properly closed. On the other hand, the correct adjustment and fixation of the maxillary bones in their right relation, with the additional advantage of better circulation for the nourishment of flaps which is secured by proper lip closure, are important factors in leading to successful results when the palate operation is performed.

Permanent Deformities of Face.—In addition to the danger of early operations, serious permanent disfigurement of the nose and face is a

matter of some moment, for interference with development of the teeth must affect the form of the maxillary bones and other osseous portions of the face, thus directly influencing the shape of the nares, the orbits, and the palate. It is axiomatic then that violent injury of any kind in early infancy, even though for the good purpose of palate closure, should only be a *dernier ressort*, and at best cannot fail to exercise a very serious and deplorably ill effect on the appearance, the general health, and the character of the voice of the individual so treated (see Figs. 435, 437, 439, 440, 441, 443, 448, 449, 452, 453, 456, 458 and 462).

At the fifth week of embryonic life the germs of developing teeth have already begun to assume distinctive form, and at birth both deciduous and permanent sets are far along toward development. Interference with growth of the maxillary bones affects quite seriously the regular eruption of these teeth in due form at the proper periods. The successfully erupting dental organs if malposed by early disturbance alter the form of the face, the oral cavity, the nares, the orbits, and more indirectly the development of the individual in such manner as to demand most careful consideration before surgical procedures are attempted. Development of the posterior portion of the palate in such cases through the newgrowth of the upper jaw, back of the first molar tooth, does sometimes show a tendency to proceed along normal lines. The incisor, cuspid, and even bicuspid regions, however, must of necessity suffer arrest of development in marked degree from the previous compression of the maxillæ upon each side of the fissure in early infancy.

Any injury, in fact, that disarranges the occlusion of the growing upper teeth so that they erupt in lingual instead of buccal or labial occlusion with their antagonists in the lower jaw will have the same effect.

Nasal Stenosis.—Stenosis of the nares is also a vital matter in considering the effect of ill-advised operations upon development. Those familiar with the various typical forms of palate fissure know that in a large proportion of cases it is physically impossible to close the cleft by immediate pressure of any kind without bringing the opposite sides of at least one naris in absolute contact, and in any case the nasal opening must be very much narrowed upon one or both sides (see Figs. 440, 443 and 450).

The question of partial or complete stenosis of the nasal passages and the natural ill-results of mouth-breathing concerns general as well as local development and general health besides. Partial nasal improvement may occur, but there can never be a normal condition in that region. The proof of this statement is at hand everywhere, for in otherwise normal individuals the relations of contracted dental arches and high palatal vaults to mouth-breathing, enlarged turbinates, spurs, hypertrophic and atrophic rhinitis, are too well understood and too apparent in daily rhinological practice to admit of further question.

Effect upon Speech.—This leads to the final claim for better speech. Individuals affected by nasal catarrh do not have good speaking voices, nor do those who are mouth-breathers with marked nasal obstructions, nor do those, as a rule, with contracted irregular dental arches and abnormally high, contracted palates. Not only is this true because of the very considerable part borne in word and sound making by those influences, but in such cases the larynx and vocal cords are subject to affections which are not favorable to the best speech or oral result.

The development in form and character of the soft palate is not as good as by later operation. More perfect plastic work may be done by the surgeon in proportion as he may with safety to his patient be deliberate in his effort to secure perfect coaptation of surfaces with exact muscular alignment of opposing muscles. Probably nowhere in the whole field of surgery is this more important than in staphylorrhapy. The chief battle at any age is so to control hemorrhage and other disadvantageous conditions which tend to increase the difficulty of operation in this necessarily somewhat awkward situation, as to make accuracy practicable notwithstanding the radical measures that are imperatively required to secure the best results.

Reasons Why Skilful Surgeons Often Fail in Those Operations.—The chief difficulty of present-day surgery of the face, lips, jaws, and palate lies in failure to grasp the underlying principles of development in this region, and want of appreciation of the proper relation of associate parts in their influence upon the form and character of these special divisions of this field of practice.

Large numbers of cases have come to the author with history of one or more previous unsuccessful operations. Quite frequently it has been evident that the general surgical skill of the operator, who nevertheless failed to secure a good result, was of high order, but not having recognized some apparently slight though really important factor, the postoperative deformity was greater than the congenital one.

SURGICAL TREATMENT OF HARELIP.

Principles.—1. The first principle of all plastic operations, and particularly *cheiloplasty* in any form, is that it is useless to attempt to secure a good cosmetic result by adjustment of the soft tissues alone, because, however perfectly this may be done at the time of operation, the future form must inevitably be determined by the outline of the underlying supporting structure.

2. The second and almost equally important principle is, that without due recognition and suitable adjustment of muscular attachments and care as to the direction of muscular fibers in uniting surfaces, the form of the lip will be correspondingly altered.

3. No matter how great the temptation may be to displace tissue for the purpose of closing a lip fissure, such a procedure must be avoided

if possible. Even though the immediate appearance at the time of operation may be better by so doing than if direct approximation had been secured by forcing the separated parts together in what would have been their normal relation, the final result will be much more perfect in the latter than in the former case. With the parts displaced, as development proceeds, asymmetry and the consequent unnatural appearance will be increased. On the other hand, even though temporary deformity results, when the parts are attached in such manner as to lead to natural physiological action, they will continue to improve as time goes on because development along right lines is thus made possible. The interdependence in such developmental relation of the mouth, nares, jaws, and bones of the face, and the coördination of muscular action as affecting both function and expression, thus alters not only the appearance of the face and lips, but of the eyes as well, and in almost equal degree. These facts have been set forth at some length in other chapters touching this subject.

These principles are quite elementary, and are not brought forward as being in any sense original, but their application in the guidance of operative procedures is not as generally observed as it should be, nor is their far-reaching influence upon future development sufficiently recognized by surgeons. All agree that the final result absolutely and inevitably depends upon symmetrical growth. Examples of this are everywhere noticeable among persons whose lips bear evidence of operative procedures in closure of harelip, and are daily object lessons when one's practice is almost wholly confined to patients of this class. Many of the deeply scarred lips, deformed noses, and distorted faces, with typical staring appearance of the eyes at the time of operation, in infancy undoubtedly appeared as though the operation were eminently successful, but succeeding years brought steadily increasing deformity.

The final test of a successful lip operation must not alone be a smooth skin surface, with the greatest possible freedom from scar tissue and nicely adjusted vermilion border, although these are matters of vital importance and worthy of the utmost possible effort to secure them. In even greater degree it is important that the nose be in proper alignment and capable of natural respiratory function, that the teeth when erupted be in good form, and that muscular attachments be correctly adjusted. The supreme tests would then be nasal respiration, and expression when the individual smiles or laughs. It is a notable fact that many lips which have a good appearance in repose are distorted during laughter, and unless there is an abundance of tissue on the under side of the lip, the tightness induced by muscular action under these conditions renders the defect particularly and often unpleasantly noticeable (Figs. 389 to 394).

The Difficulties in Cheiloplasty.—The adverse conditions to be overcome in correction of harelip are:

Tension.—Tension as the intervening fissure is overcome by stretching the parts across.

Maldevelopment.—Maldevelopment of the projecting premaxilla, which tends to widen the fissure and make its closure more difficult.

FIG. 389.—Infant with harelip and complete cleft palate. The nose has been partially straightened, and the fissures made narrower by wearing an adhesive strip as described.

FIG. 390.—The same child as in Fig. 389, at the age of two and one-half years, after both lip and palate have been closed.

FIG. 391.—The same child shown in Figs. 389 and 390. Test of the operative result during laughter.

FIG. 392.—Another view of the same child as in Figs. 389, 390 and 391.

Nasal Deformity.—Nasal deformity due to distorted development in the maxillary region, which carries with it deflection of the attached vomer and nasal septum. Through this agency and because of the

abnormal muscular action thus engendered, when the fissure extends through into the nose, the triangular cartilage is also deflected. The abnormal situation of the detached maxillary bones through adverse muscular action draws the cartilaginous wing in such form as to leave it flattened and sometimes curved in the wrong direction.

Irregularity of the Dental Arch.—If the situation of the premaxilla is not corrected in early life the maleruption of teeth in this region will inevitably increase the deformity. If in an effort to restore the premaxilla to its natural position forcible methods are applied through traumatic injury to the developing teeth germs, there may be failure

FIG. 393.—Later picture of child shown as an infant and at two and one-half years old in Figs. 389 to 392. Symmetrical nasal, labial, and facial form gives proof of the correctness of the principles herein set forth with regard to early treatment.

of certain teeth to erupt, in which case maxillary development will be arrested, or otherwise perverted, and irregularity of the teeth will be brought about. In either condition there will be deformity which must tend to increase instead of decrease as the individual gets older.

Operative Defects.—Imperfect adjustment of the prolabium, leading to the following results: (*a*) Notch or V-shaped space at the lower border of lip; (*b*) one side higher than the other; (*c*) excess of tissue causing projection beyond the proper line; (*d*) a white surface extending upon the mucous membrane of the prolabium; (*e*) naris upon the affected side unusually large or too small; (*f*) the transverse or other scars which stiffen and mar the appearance of the lip; (*g*) depression

along the line of attachment; (*h*) unusual broadness across the base of the nose, excessive development of the triangular cartilage leading to marked enlargement, a perpendicular groove through its central

FIG. 394.—Infant with double harelip; shows characteristic projection of the premaxilla, and philtrum of the upper lip.

FIG. 395.—Same infant as in Fig. 394 with adhesive strip adjusted to reduce the deformity as described in the text.

portion or tipping down to its under surface; (*i*) in double harelip cases, depression in the premaxillary region, flattened appearance of the nose, displacement of the parts, so that the small portion of upper lip tissue (the philtrum) which is usually attached to the pro-

jecting premaxilla becomes part of the nose instead of the lip, unusual length of the upper lip, which is then drawn downward and inward and is associated with a beak-like appearance of the nose, unusual length to the upper lip with bulging forward in its central portion and a tightly drawn appearance at the red border; (*j*) altered appearance of the eyes in all of these cases. The unnatural tension of malmus-

FIG. 396.—Same infant as in Figs. 394 and 395. Front view before operation shows the benefit derived from wearing the adhesive strip for about ten days.

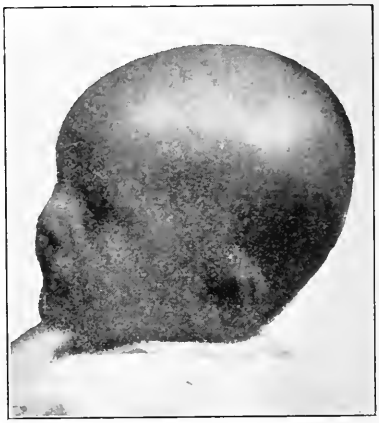


FIG. 397.—Same infant as in Figs. 394, 395 and 396. Profile view before operation shows the improvement made by the strip of adhesive plaster worn across the lip for ten days.

FIG. 398.—Infant with double harelip deformity reduced by wearing an adhesive strip across the lip ready for operation.

cular action causes a strange staring of the eyes. Occasionally this is so marked as to effect the supra-orbital tissues also. Thus one eye may appear to be higher than the other, and there is quite often an appearance of *exophthalmos*, which is due to surrounding structures rather than to any peculiar form of the eyeball (see Figs. 435 to 457).

Methods for Overcoming Difficulties.—It is the author's purpose to present a clear description of his methods for overcoming the fore-

going difficulties. Part of the technic is original, part the adaptation of other methods.

FIG. 399.—Infant with double harelip.

FIG. 400.—Same infant as in Fig. 399 after lip operation. In this case, when the palate was closed one year later, the teeth were found to be erupting quite normally.

FIG. 401.—Double harelip and cleft palate

FIG. 402.—Same infant shown in Fig. 401 after both lip and palate have been closed, and deformity corrected.

Operation to Close Lip Fissure on Day of Birth or Soon After.—If it be practicable to get the child immediately or within the first few days

after birth, it is of great advantage to perform the lip operation at that time. In this way widening of the fissure is prevented, and a newborn infant sleeps so much of the time, that there is very little tendency to disturb the sutures and cause irritation or later scars.

FIG. 403.—Infant with double harelip.

FIG. 404.—Same child after operation. Both lip and palate fissures have been closed.

FIG. 405.—Infant with double harelip.

FIG. 406.—Same case as shown in Fig. 405.

The Use of Zinc Oxide Adhesive Strip.—If very early operation cannot be performed then the simplest and most effective method of accomplishing this is by the adjustment of a strip across the lip, as shown in Fig. 395. When the fissure had been sufficiently narrowed and the premaxilla brought around and backward into approximately normal situation, it will be noticed that marked improvement in

nasal form has also taken place. Whatever this treatment may not have accomplished in the direction of nasal improvement must be

FIG. 407.—Infant showing characteristic deformity in double harelip.

FIG. 408.—Same child as shown in Fig. 407 after both lip and palate have been closed by operations. Eight months after operation on lip

FIG. 409.—Boy, aged four years, with double harelip and cleft palate. Shows increase of the deformity as the child became older.

FIG. 410.—Same boy as in Fig. 409 after excision of a section of the vomer, and correction of the deformity.

done at the time of operation. Therefore operative procedures must include provision for this result (Figs. 396, 397 and 398).

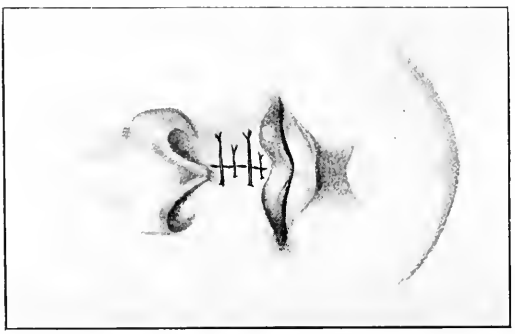


FIG. 413.—Nélaton's operation; sutures in place.

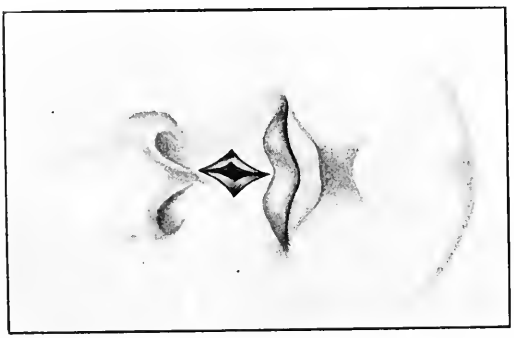


FIG. 412.—Nélaton's operation; method of adjustment.

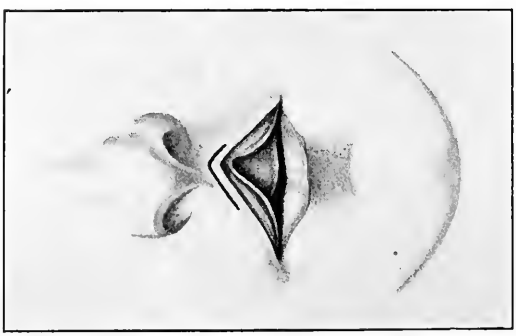


FIG. 411.—Nélaton's operation; the incision.

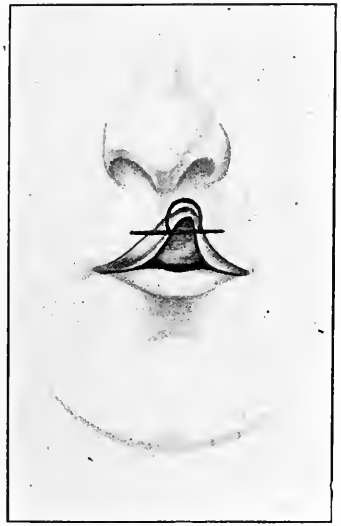


FIG. 414.—Malgaigne operation; the incision.

FIG. 415.—Malgaigne operation; method of adjustment.

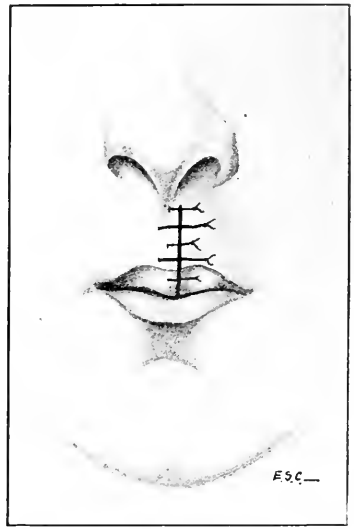


FIG. 416.—Malgaigne operation; sutures in place.

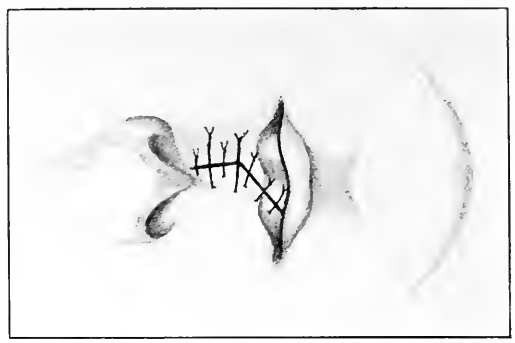


FIG. 419.—Mirault's operation; sutures in place.

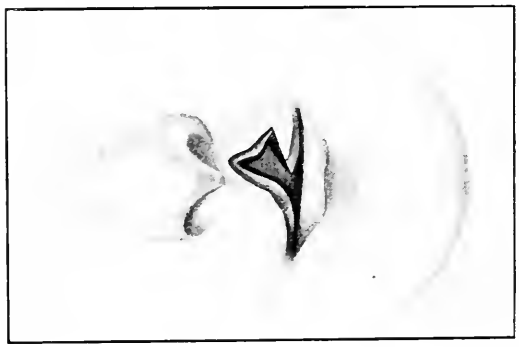


FIG. 418.—Mirault's operation; method of adjustment.

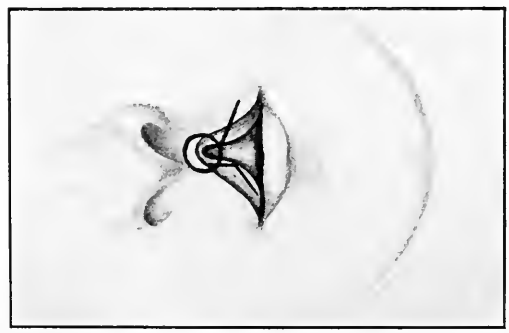


FIG. 417.—Mirault's operation; the incision.

FIG. 420.—Double harelip operation; the incisions as advocated with slight variations by von Langenbeck, Mirault, Maas, and others.

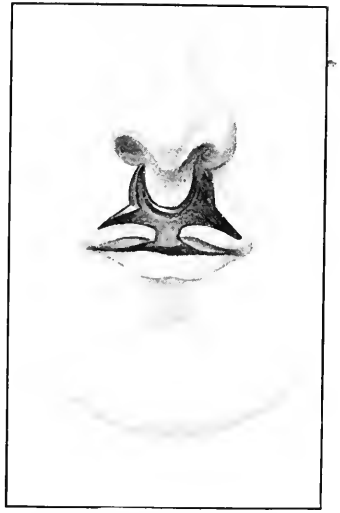


FIG. 421.—Double harelip operation; the method of adjustment in accordance with the incisions outlined in Fig. 420.

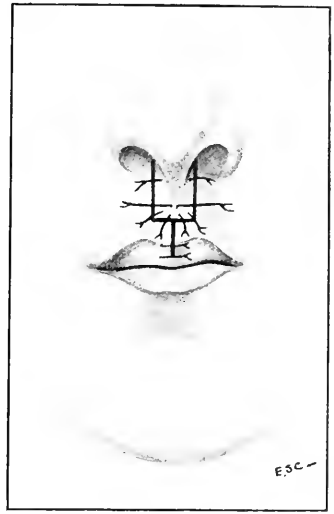


FIG. 422.—Double harelip operation; the sutures are placed to correspond with the incisions and method of adjustment as outlined in Figs. 420 and 421. This method of operation creates an ugly deformity by making the lip too long, and should be avoided. (Author.)

Nasal Splint and Tension Suture.—The author has devised a suture (see Fig. 424), which is employed in such manner as to be at once a nasal splint and a tension suture to hold the nasal septum and triangular cartilage of the nose in correct alignment, the cartilaginous wing upon the affected side in proper form and situation, and the tissues of the cheek, lip, and facial muscles in such position that when severed and reattached their points of attachment will be improved. While doing all this, tension from the approximated wound surface is relieved. This suture is of the same form as that which he uses in cleft palate operations.

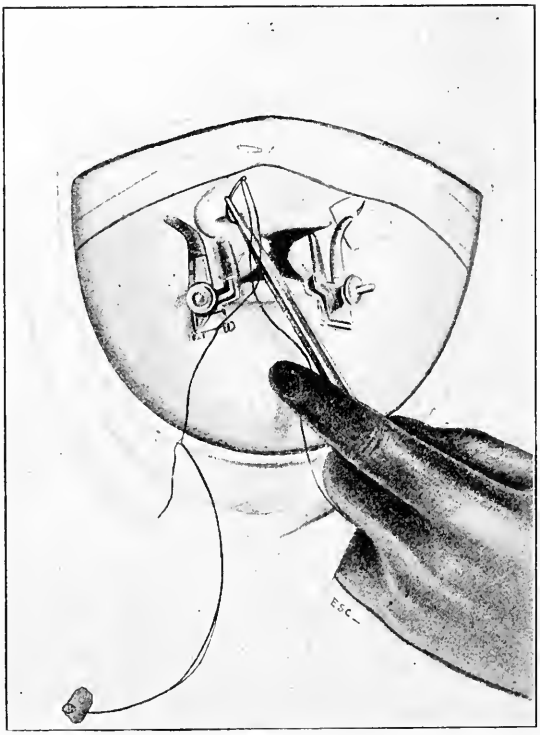


FIG. 423.—The author's method of harelip operation. The illustration shows the author's lip clamp in position. The wire suture with silver plate for septum splint, the lead suture of silk or linen, the adhesive square for protection of the skin surface and the method of introduction of this suture.

A needle carrying a silkworm gut, or as formerly used a silk or linen ligature attached to a wire suture is passed through from the naris upon the opposite side if the case be one of single harelip, carried through the affected naris, and brought out upon the cheek a little below and beyond the external border of the ala on the affected side (Fig. 423). The silver plate that has been previously attached to the

suture is changed from its usual square shape to oblong form, its width and length being adjusted to fit the nose so as to prevent buckling or other distortion when drawn into place against the septum. At the point where it is drawn through the cheek a square of zinc oxide adhesive plaster, somewhat larger than the silver plate and having a small hole in the center, is slipped over the suture down to the skin surface. A small, square silver plate, with suitably perforated holes, is again passed over the suture and following this are perforated lead shot, which can at a proper time be compressed and thus made to hold their parts in their proper position (Fig. 424). This simple suture is

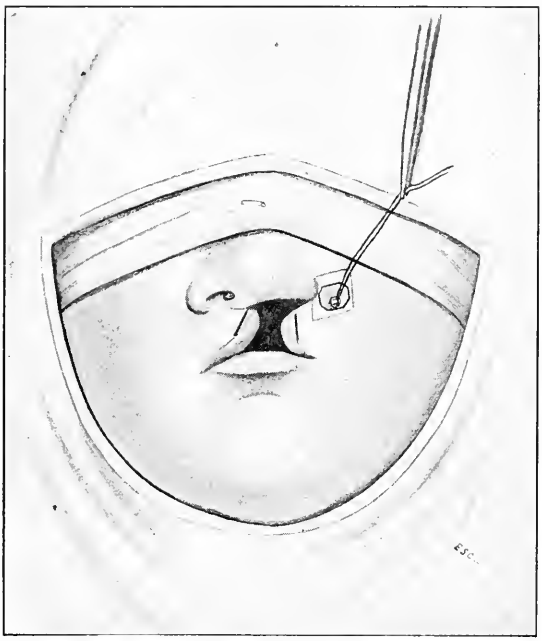


FIG. 424.—The author's method of single harelip operation. The wire splint and tension suture in place with silver plate and compressed lead shot in position. Outline of lip incision. Silkworm gut may be substituted for wire, with good result.

the key to the whole situation. It not only holds the parts in proper relation as described, but when tightened gives the necessary pressure to control the severe hemorrhage which sometimes follows the free incisions. The latter are necessary to sever muscular attachments, and it is of the utmost importance that they should be thoroughly and extensively carried out, thus relieving the tension of muscular action during the early part of the healing process and affording the readjusted muscular attachment that is so necessary to the best final result.

Compression of Vessels.—The hemorrhage can be materially reduced and the operative steps facilitated by making compression of the

coronary arteries. The author's clamp for this purpose is shown in Fig. 423. (See Plate XX.)

In infant cases the double clamp shown in the illustration is unnecessary. Any form of compressor which will not do injury to the parts and not be in the way of the operator will do equally well. In adult cases, however, the double clamp serves the purpose of controlling hemorrhage with less pressure than a single clamp sometimes requires; it also serves to keep the two sides of the lip extended, and in this way favors accuracy in making incisions to secure correct length of the lip and adjustment of the border of the prolabium. The weight of the attachment also assists in this direction.

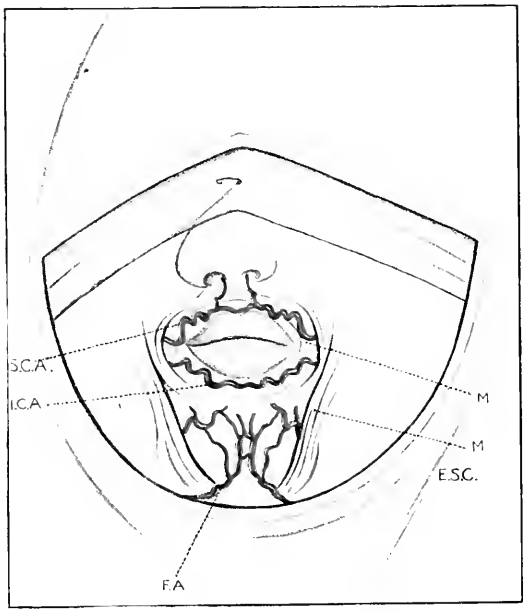
Incisions.—As may be seen from a study of Figs. 411 to 422 inclusive, many different forms of freshening the lip fissure borders and of forming flaps to secure the necessary adjustment of the divided lip surfaces and suitable outline for the prolabium have been devised and advocated from time to time by different operators. Without entering into a detailed description of the advantages and disadvantages of each one, the principle already referred to may be safely depended upon for guidance, namely, that any incision which alters the normal relation of the muscular fibers of the parts, even though temporarily advantageous, will ultimately destroy the natural expression and form of the nose and lips.

The author's incision, shown in Fig. 424, is begun at points upon each side, as exactly as can be determined, in line with junction of the nose and lip, and carried downward through the full depth of the lip tissue to the border of the prolabium. Care must be taken that the knife divides the skin throughout the length of the incision; for if any part of the mucous membrane along the fissure is left, it will always remain as an ugly, red-looking, offensive scar. The slant of incision away from the central line upon each side depends upon the length of the lip, because the point at which the prolabium is reached must be so located as to allow each side to give the lip its proper length at the line of union. When such flaps are turned down, as shown in Fig. 425, it will be found that they are much too long, and if united without care in their adjustment, will result in an unsightly lump or unusual lengthening of the lip, as may be found in many cases where operation has been performed without due regard for this fact. It will also be found that there is a strip of skin included in each flap. If any part of this remains, it will always show as a white scar in the red border of the lip.

To avoid these defects and at the same time to prevent the removal of too much tissue which might result in the unsightly notch that is so characteristic of these cases when improperly operated upon, and to give sufficient thickness at the lower border of the lip, to retain the natural outward curve, the knife, in excising the skin and the slight amount of superfluous tissue that may be in the flap, should be carried at a slant from without inward and toward the center.

It is impossible to set a fixed rule for the allowance that must be

PLATE XX



S. C. A., superior coronary artery and its nasal branches; *I. C. A.*, inferior coronary artery; *F. A.*, anastomosis of the inferior labial and submental branches of the facial arteries; *M, M*, orbicularis oris and depressor anguli oris muscles.

made in the way of surplus tissue at this point. The operator must be governed by the exigencies of the particular case.

It may be said, however, that the contraction of scar tissue along the line of incision should not be great, and it should never be necessary to make allowance for it in anything like the degree that some writers indicate. Shortness of the lip and notches, as a rule, result from improper allowance for the corresponding length of tissue upon opposite sides of the fissure. The raw lip borders are next split sufficiently to insure thickness which will prevent depression along the line of the scar when the wound is healed.

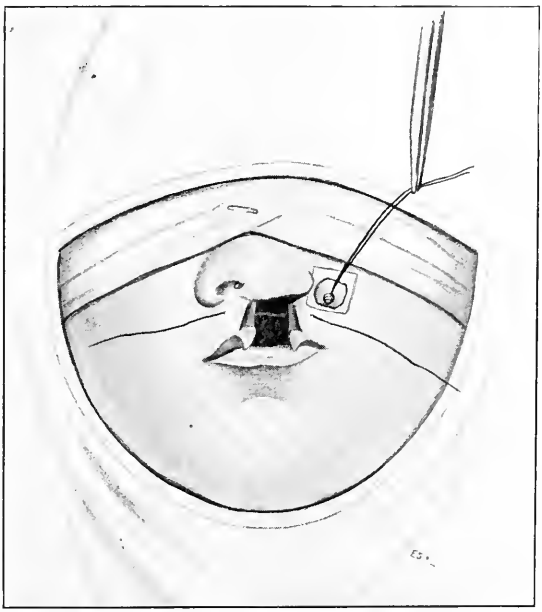


FIG. 425.—The author's method of single harelip operation. Fissure borders denuded and split. The prolabium flaps prepared for suturing. The first control suture in place.

The first suture, as shown in Fig. 425, is so placed as to include the nasal branch of the artery, as may be seen by reference to Plate XX. This suture is placed well back into the skin and entirely through the lip upon each side. It serves the temporary purpose of controlling hemorrhage at this time and holding the wound surfaces together, so that more accurate adjustment can be made at the lip and nasal borders. This suture is not completely tied at once, but is left so that it may be loosened or tightened as required; and the ends are temporarily clamped with a forceps. The lip on each side is then raised, and with a broad knife or scissors, or both, the muscular attachment is freely severed. Upon the side of the fissure this must include freeing the cartilaginous wing of the nose as completely as possible. The profuse

hemorrhage which follows these incisions is instantly checked by pressure of the assistant's fingers upon the cheeks. The suture through the nose, which up to this time has been lightly clamped, is now tightened by forcing the silver plate upon the external surface farther in upon this suture, and the shot compressed to hold it. This invariably gives the necessary compression to check hemorrhage, and may be depended upon to control it permanently.

When this adjustment is completed it will sometimes be found that the direction of the first suture is no longer suitable. After another suture has been placed, which is carried through the skin and muscular tissues upon each side, but does not include the mucous membrane upon the buccal side of the lips, which may be accurately adjusted and left as one of the tension sutures, the first suture may then be removed.

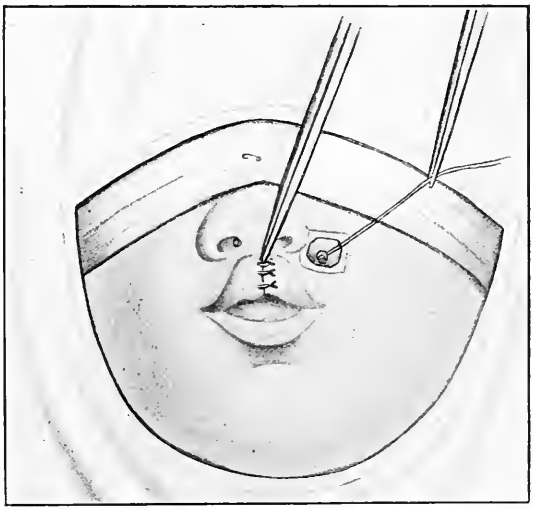


FIG. 426.—The author's method of single harelip operation. Sutures placed along the mucous membrane surface of the lip.

Before the final adjustment of the sutures upon the anterior surface of the lip and the prolabium, the lip is everted and catgut sutures are placed along the inside of the lip, as shown in Fig. 426. This insures against the likelihood of infection from the mouth, because the mucous membrane surfaces close quickly when properly approximated. It also to some extent takes the strain off of the external sutures and prevents the likelihood of their cutting or marking the skin. At the same time it serves to fix the outline of the form of the lip so that the skin sutures may be accurately adjusted.

For the approximation of the skin surfaces the author prefers interrupted sutures. Notwithstanding the claims that have been made for the subcuticular suture, it does not seem to hold skin borders with the perfect accuracy required for the least possible scar.

Except where fault has occurred for some other reason, the marks of the interrupted sutures have been seldom found such as to cause an unsightly appearance of the lip. Usually two catgut sutures are placed reasonably well apart to resist the first effect of strain along the line of union. Extremely fine cambric needles, the smallest size made, with silk (or 2000 fine linen) fine enough to permit their use, are employed to coapt the skin borders accurately. At the prolabium and occasionally at points in the skin surface the author uses horse-hair. Its chief advantage is that its elasticity sometimes permits accuracy in its use, which it is difficult to secure with a non-elastic suture material. How great or how little the importance of this may be is to some extent a matter of conjecture.

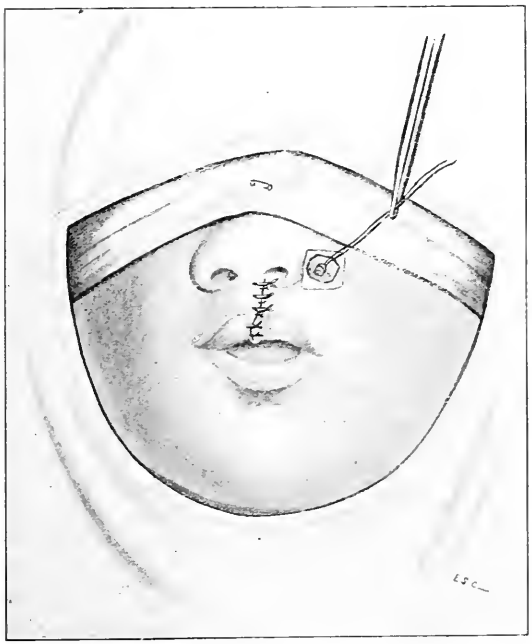


FIG. 427.—Shows diagonal line of approximation. Skin sutures in place.

The floor of the nose should be as carefully fashioned as the condition of the patient and the circumstances under which operation must be performed will permit. It must be remembered in this connection that many of these infants are in an extremely precarious condition, so much so that the time element is of vital importance. By dissecting free the divided tissue upon each side along the floor of the mouth at the external opening of the naris, one or two sutures can easily be placed just inside and close to the external opening. This will not only serve to give greater perfection in the external

appearance of the nose and lip, but, as explained later, will sometimes have a great influence upon speech also.

The situation and the direction of the line of union as affecting the later scar should be borne in mind when the incisions are made.

The author's preference, wherever possible, is to have the line of union slanting, so that the point of junction at the prolabium will not be directly under the beginning of the wound at the nose. Such a scar as may remain under these circumstances is much less noticeable, and is less likely to draw the lip in an unsightly way during laughter. Even when it does attract attention it is less apt to suggest immediately the thought of harelip. The scars of accidental lip injuries are for many reasons less objectionable than the mark of a congenital defect, such as harelip (Fig. 427).

Treatment of Double Harelip.—In these cases there is great difference in the appearance and corrective requirements. The premaxilla may project in such manner as to cause great deformity and be difficult to place, or the portion of the lip attached to the premaxilla may be so small and of such poor character as to make its presence difficult to detect. In most young infants the vomer and nasal sections are yielding, and it is comparatively easy to force the parts into fairly good relation. Occasionally a child is met in which even at birth considerable ossification has taken place. Figs. 394 to 410 are examples of these cases.

Reduction of the Premaxilla.—Were it not that cases are occasionally met with in which excision of the premaxilla has been comparatively recently performed to facilitate the closure of double harelip, it would seem unnecessary to warn against this practice.

Its results may be seen in Figs. 448, 453 and 456, and these examples might be repeated almost indefinitely among individuals operated upon according to older methods.

This apparently useless and often embarrassing excrescence projecting from the end of the nose, with a detached portion of the lip upon the upper or anterior surface even in the newly born, contains the germs of both deciduous and permanent central incisor teeth, and frequently the lateral incisors also.

The loss, misplacement, or traumatic injury, which may severely injure any growing part of this premaxilla, will cause deformity to mar the features of the individual for life. Adjustment of the zinc oxide adhesive strip has already been described. Figs. 394 to 410 show what may be done in this way. When such a strip is adjusted for the first time, pressure with the ball of the operator's thumb may be employed to force the premaxilla back in the direction of its proper situation. In older infants the vomer may be split with a periosteal elevator or a strong knife. This separates the two divisions due to its double development. Pressure on the premaxilla causes folding of the parts, and permits proper placement of the parts with the least possible deformity. By cutting diagonally, the parts may be slid

past each other if necessary, as adjustment takes place and no tissue is lost. The excision of a V-shaped portion of the vomer, as commonly recommended, will almost certainly result in a rabbit-shaped mouth that is exceedingly displeasing in appearance.

Only in old cases where the vomer has become thick and altogether excessive (Figs. 409 and 410) should any of this structure be removed, and then with such care as to prevent deformity if possible.

Incisions.—Von Langenbeck's method (Fig. 420), or some modification such as the Maas and Hagedorn operations, has been most generally followed by surgeons during recent years.

In this way the premaxilla is preserved and a portion of its labial attachment also, but another kind of deformity is created. The characteristic appearance of patients operated on according to this plan may be noted in Figs. 449 and 452.

During infancy the results in these cases may appear to be all that might be desired, but with advancing growth a progressive increase in objectionable appearance takes place. The transverse scars of the united flaps that have been carried across and joined to the lower border of the central lip segment contract or at least yield less readily than the normal structures. The effect of this is to cause the anterior portion of the maxilla to bulge forward and the scar band to be drawn downward and inward.

In many patients who have come to the author this had already caused the upper lip to become abnormally long, with most unsightly convexity on the anterior aspect.

The author believes that every portion of the lip tissue on the anterior surface of the premaxilla should be preserved if possible; that even though it be scant in size and thickness, it should, nevertheless, be treated as though it were the full lip section that it represents; that attempts to excise it completely and to create a single central line of union almost always fail to give a good result in later life, because of the alterations that are created by attempted natural growth; that if properly united to the muscle fibers of the lateral portions of the lip, the natural function thus made possible will lead to proper growth and development.

There may always be a disproportion between the thickness of the central and lateral portions of such a lip, and the lip so treated may remain too short notwithstanding its increased opportunities for growth, but from wide experience in the correction of lip defects, the author unhesitatingly states that such a lip can be improved in later life and made to present a more natural appearance than a mutilated lip ever can.

Technic of the Author's Operation for Double Harelip.—The same kind of suture that has been described with reference to single harelip operations is used in double cases. The needle is inserted just outside the ala upon one side, carried through the nasal septum, and out upon the opposite side just beyond the ala. The skin is protected with squares

of zinc oxide adhesive, and a silver plate is adjusted with perforated lead shot clamped upon wire. This holds nose, cheeks, and lips in correct relation, checks hemorrhage, and relieves the principal strain upon the sutures.

In other respects the operation is performed in the same manner as in single cases, except that there are two rows of sutures instead of one (Figs. 428, 429 and 430).

Great care is sometimes necessary in suturing the central division of the lip securely to the lateral portions without traumatic injury or interference with circulation sufficient to cause sloughing. With

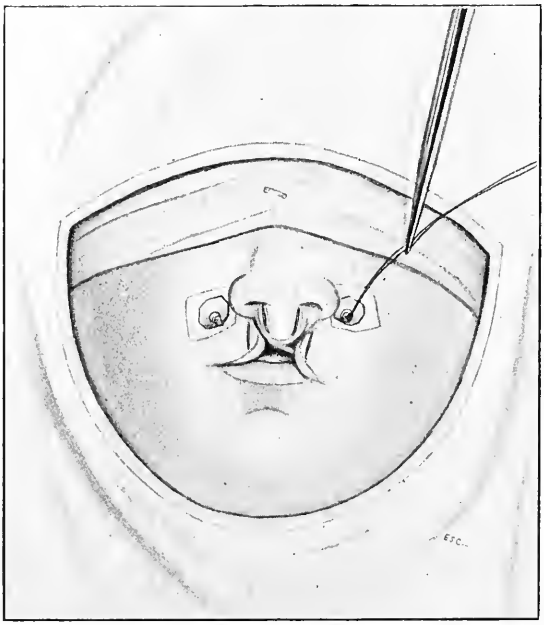


FIG. 428.—Author's method of double harelip operation. Splint suture for retention and correction of the deformity of the nasal septum in place. Outline of the incisions.

perfect control of the situation during operation, and delicate manipulation with fine needles and sutures, such a result may never occur, and never has in the author's experience, except years ago in some of his earliest cases in which methods advocated by others were used.

That extensive sloughing may follow either single or double harelip operations is shown by Figs. 435, 437, 439 and 440. These cases were brought to the author for operation after such failure had been allowed to take place.

Postoperative Control Strips and Dressings.—The author's method of strapping infants and some older patients after harelip operations is illustrated in Fig. 431.

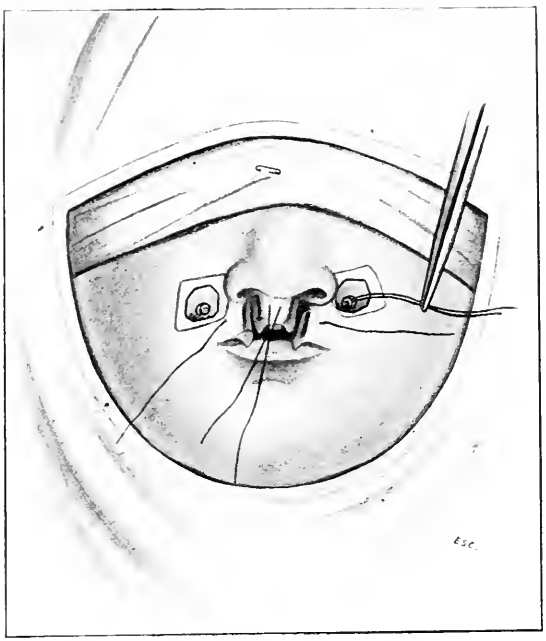


FIG. 429.—Author's method of double harelip operation. Fissure borders prepared for the sutures. First control suture in place.

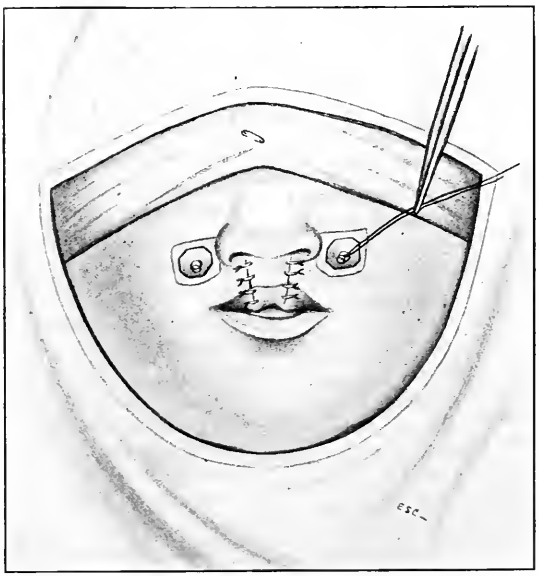


FIG. 430.—Author's method of double harelip operation. The operation completed and skin suture in place.

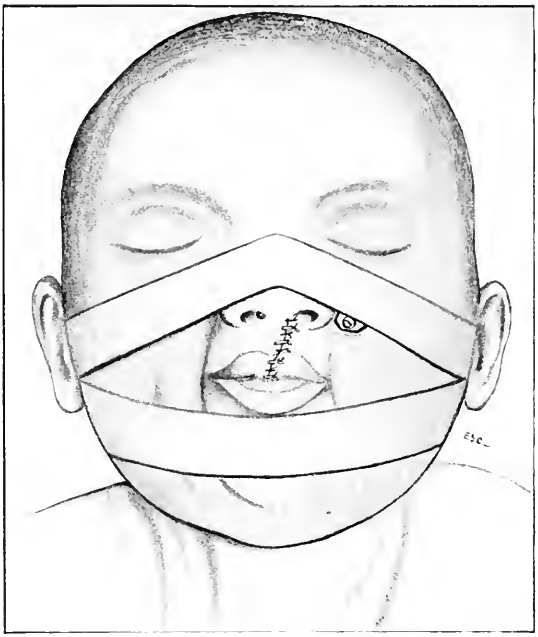


FIG. 431.—The adhesive strip carried from the cheek upon one side across the bridge of the nose to a corresponding point upon the opposite side of the face. Another adhesive strip attached upon the cheek upon one side just below the upper strip, and carried across the chin to a corresponding point upon the opposite cheek. Both of these strips are drawn just tight enough to relieve tension upon the lip sutures, and the lower one is so adjusted as to hold the lips slightly apart to favor respiration after operation. (Author's method.)

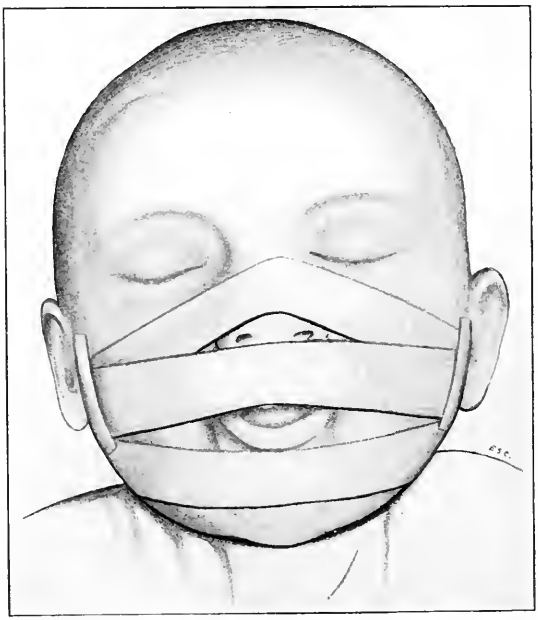


FIG. 432.—Dry sterilized gauze laid lightly across the lip and attached at each end with short, narrow adhesive strips. This dressing can be removed whenever necessary without removing the adhesive tension control strips. (Author's method.)

A strip of zinc oxide adhesive as wide as the nose is long is carried from the cheek on one side, over the nose, to the cheek upon the other side. It is then drawn tightly enough to wrinkle the cheek slightly and firmly attached. A second strip is attached to the cheek upon one side, carried over the chin to the opposite cheek, with care to adjust in such manner that the lower lip will be kept slightly open. If the skin surfaces have been cleaned and dried with ether, these adhesive strips will hold in position until the sutures are removed. The dressing is laid lightly across the lip and attached with short, narrow adhesive strips. This may be removed by the nurse whenever it becomes soiled, without the disturbing retention strips (Fig. 432).

FIG. 433.—Harelip without cleft palate, except fissure through the alveolar ridge. The projecting premaxilla in these cases is fixed and unyielding.

FIG. 434.—The same girl after forcible correction of the deformity and closure of the lip.

Treatment of Harelip without Cleft Palate.—When there is palate fissure associated with harelip, much more adjustment and improvement after operation may be expected than will be found to occur in cases in which the hard palate is complete, except for the single or double fissures which in accordance with the character of the lip deformity extend through the alveolar ridge.

Surgeons who are unaccustomed to these cases usually operate in the belief that they are much simpler than the wider and more difficult-looking fissures, that include both lip and palate. Error in this respect has led to many postoperative deformities. The real difficulty is that the premaxilla always projects forward more or less in the same manner, though not in such a marked degree, as with the former class of cases.

The solid resistance of the full-formed palate behind yields less readily to action of the lip muscles than where there is a division which gives greater freedom in adjustment of the misplaced parts.

When children have passed beyond the period of infancy there must always be a definite reduction of the premaxilla and adjustment in at least approximately correct position accomplished by surgical means.

After the teeth have developed the parts are held in position by wires attached to the teeth or metal bands are cemented upon the tooth crowns, to which is attached an appliance such as any dentist might construct to hold the parts firmly until united. In most cases it is better to do this at a preliminary operation and later to close the lip perfectly, when there will be no likelihood of infection of the lip from the mouth wound. This was done in the case of the patient illustrated in Figs. 433 and 434.

A deflected nose is much more likely to persist and cause a less perfect facial appearance than in other cases.

The Removal of Scars and the Correction of Postoperative Lip and Nose Defects.—Naris too Large.—If the floor of the nose has not been properly closed in conjunction with lip or palate operation, one naris, or even both, may not only be unsightly, but may also interfere with speech through allowing the wrong escape of air.

In these cases the tissue at each side of the depression or fissure in the floor of the affected naris may be incised sufficiently far back to allow the necessary correction. It is then dissected free and raised. Usually the septum will be deflected in single cases, and the large flattened ala also require reduction. The narrowing effects in correction of these associated defects allows the tissues at the line of intranasal approximation to be raised in such a manner as to make the parts remain permanently in corrected position when united, and the floor of the naris to be correspondingly benefited.

The characteristic deflection of the septum resulting from failure to care for this defect when the harelip is closed the author corrects by inserting a suture with splints, as described for harelip, from the opposite side of the septum and put through the cheek just beyond the cartilaginous wing of the nose. When tightened it will draw the septum in the desired direction. The upper lip is then raised and a cartilage knife passed through from beneath the lip and the septum divided at its attachment with the superior maxilla, as far back as may be required to correct the anterior deviation. It is then drawn into position and fixed with a wire suture. The oral opening is so small that when the lip drops back into position it is practically closed.

The effect of this treatment may be seen in Figs. 435, 436, 437 and 438.

In most of these cases operation is performed incidentally to the operation for removal of scars and other objectionable features.

The Correction of a Notch or V-Shaped Space at the Lower Border of the Lip and Shortness Resulting from Imperfect Closure of the Lip Fissure.—Effort should be made to preserve the prolabium as nearly intact as possible. This may not always be accomplished, but usually results

FIG. 435.—Child, aged two and one-half years. One-half of lip and palate almost totally destroyed as a result of attempted closure of lip and palate at the same time. Forcible compression of the side of the palate was attempted in early infancy.

FIG. 436.—The result of closure of the lip for the little girl shown in Fig. 435.

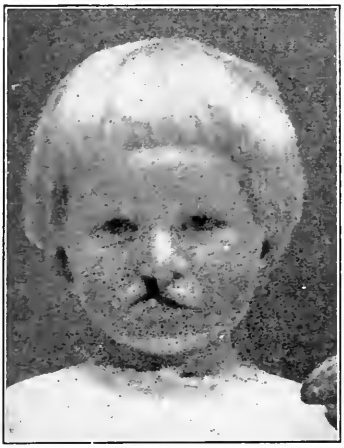


FIG. 437.—Child, aged three years. Lip nearly half lost by operation upon both lip and palate at the same time in early infancy.

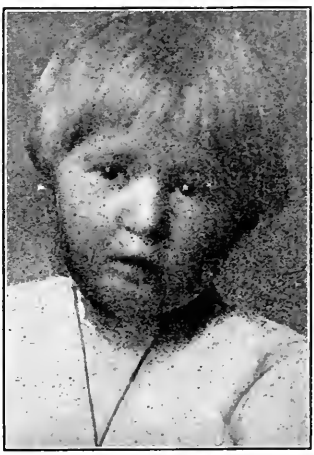


FIG. 438.—Same child shown in Fig. 437 after closure of the lip fissure.

quite naturally when a transverse incision is made and the lower portion of the lip is drawn down until the transverse line is converted into a perpendicular one. The length of the incision for the elimination

of the defect will, as a matter of course, be governed by the amount of lengthening the lip requires.

When One Side of the Lip is Higher than the Other at the Border.—Usually a considerable amount of scar tissue must be removed. It is the author's custom when removing scars of the lips to follow the scar upon each side with a knife until it is dissected out as completely as possible. Then incisions are made without regard to scar tissue to effect the desired improvement. Almost invariably, when this scar is dissected out, the lip is much more easily adjusted to its proper

FIG. 439.—Front view of boy, aged four years, for whom the operation of forcibly closing his palate fissure and attempting to hold the parts with wire and lead plates was performed in early infancy. The lip was closed at the same operation. Both lip and palate sloughed out except for a small bridge of tissue which fixed the maxillary bones as placed. Not only did he lose almost the entire lip upon one side, but the deformed shape of his face, which is characteristic of the result of these operations, remains permanently, as is plainly shown in the illustration.

FIG. 440.—Profile view of the same boy as in Fig. 439. The malposition of the maxillæ and consequent deformity of the nose which resulted from forcing these bones together to close the palate fissure in early infancy are markedly apparent.

position; therefore not only is the unsightliness removed by excision of scar tissue but the approximation of the parts is favored. Care must be taken not to cut completely through the lip if it can possibly be avoided, because this invites infection from oral secretions and has a tendency to produce more scar tissue. With the lip tissue thus set free, the operator must be guided in adjustment of the parts as the indications require, and this can only be accurately determined by drawing them into contact and placing and replacing them in the

desired position until perfection is secured. Set rules for making incisions in such cases are misleading, and implicit obedience to them

FIG. 441.—Infant with double harelip and cleft palate. The history of this case before coming to the author shows that a few days after birth an attempt was made to close the palate fissure by the use of silver wire and lead plates. The wires sloughed out and there was a general infection, as a result of which the child was in a very critical state for several weeks before recovery.

FIG. 442.—The same baby after the lip and hard palate have been closed. It will be seen that it was impossible to get as perfect a result as might have been obtained had the first operation not been performed.

FIG. 443.—Boy whose nose, lip and palate were almost hopelessly deformed by compression and wiring his maxillary bones to close a palate fissure in early infancy. It will take long patient work to even partially restore the shape of his mouth, and one or more lip operations to improve his appearance. He is a great sufferer from nasal disease, as is nearly always the case with such operative results.

almost invariably results in failure. The operator must be controlled by the guidance of his own judgment.

In the Excision of Excessive Tissue Causing Projection Beyond the Proper Outline of the Lip Border and the Shortening of a Lip that is too Long or Removal of Excessive Size.—Such cases of macrocheilia are illustrated in Figs. 368, 369 and 370. Great care must be exercised to make the knife follow the exact outline of the proper curve of the prolabium at its junction with the skin border. This is not so easily

FIG. 444.—Lip, nose and palate deformed by compression in early palate operation, and making the lip too long by carrying flaps across the philtrum as usually performed in double harelip cases.

FIG. 445.—Same boy shown in Fig. 444 after operation to shorten and restore lip, and forcing the premaxilla forward with appliances attached to the teeth according to orthodontic methods.

done as might appear, because when holding the lip taut while the knife is drawn across, the form will be changed unless this alteration is provided for.

It is the author's custom to mark the surface with a very sharp knife, and then as the incision is deepened the first marking can be

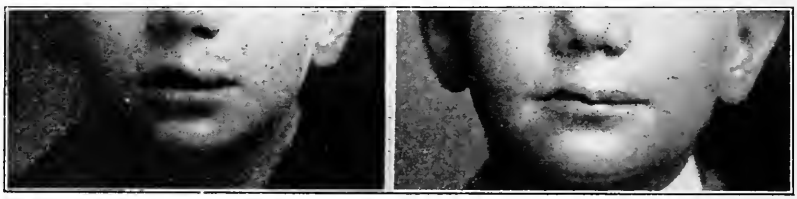


FIG. 446.—Boy, aged nine years. Previous history shows that an operation was performed in early infancy in which an endeavor was made to close the palate by the use of wires through the jaws and lead retaining plates. This failed disastrously, and was followed by four other operations with only partial success. The difficulties were enormously increased by the effect of the early infancy operation.

FIG. 447.—Same boy as shown in Fig. 446, after lip and nose have been reconstructed and the palate fissure closed by two operations. It was necessary to readjust the malposed parts and partly close the palate fissure at the first operation, and to complete the closure one year later. Since this picture was taken he has been for several years under treatment by his dentist, who has been endeavoring to bring the malposed teeth into proper alignment. (Author's article, Ochsner's Surgery.)

followed. In most cases sufficient excessive tissue can be removed and the mucous membrane so cut as to allow proper restoration of the form of the lip when it is drawn up and sutured to the skin border. A scar at or just above the junction of the skin and mucous membrane which properly follows the outline of the prolabium will not be distinctly noticeable after operation. Not much can be done with transverse

scars across the lips except in cases where they may be included when the lip is shortened or the lip so formed as to cause it to have an

FIG. 448.—Boy, aged seven years. Shows the characteristic facial appearance after the removal of the intermaxillary bone in operation for double harelip.

FIG. 449.—Front view of same boy shown in Fig. 448. His palate was closed in early infancy with what appeared to be a successful operation. The result at seven years old may be seen. Complete stenosis of left naris, right side of nose almost absolutely useless for breathing purposes, although probe can be passed through. Disproportion between the upper and lower parts of the face and head due to arrest of development. Voice shrill, high, and by no means perfect in pronunciation.

FIG. 450.—Front view of same boy shown in Figs. 448 and 449 after operation for the correction of his lip and facial defects.

FIG. 451.—Side view of boy in Figs. 448, 449 and 450 after operation for the restoration of more natural lines in profile.

outward roll, such as is often seen in natural lips and which serves to make the transverse marks less noticeable. One must always guard against making the lip too short. Better leave too much and correct it afterward if necessary than to take away too much tissue and spoil the lip.

Depression along the line of union must be avoided in lip operations by splitting the tissue upon each side of the wound so that there may be thickness enough to overcome the result of cicatricial contraction during the healing process. By cutting through the skin with his knife on a slant, so that there will be a slight tendency to lap when the

FIG. 452.—Face of boy, aged fourteen years, showing in front view the result of imperfect early operation for double harelip which is apparent in deformed nasal form; almost complete nasal stenosis; arrest of maxillary developments, due to loss of premaxillary structures and anterior permanent teeth; upper lip too long and badly marked with deep scars, and eyes staring on account of unnatural muscular tension.

FIG. 453.—Same boy as Fig. 452. Side view of the deformity.

surfaces are approximated, the author finds that there is less tendency to scar appearance than when perfectly straight incisions are made. After careful trial, however, he has demonstrated that a very great slant, one that would leave an exceedingly thin flap of skin upon the upper side to spread over the lower one, as has been recommended for skin surface approximation, is disappointing because, in spite of all precaution, there will often be a tendency for the thin edge of skin to shrivel up and leave a greater scar mark than would have resulted from a perfectly straight incision.

FIG. 454.—Side view of boy shown in Figs. 452 and 453 after operation.

FIG. 455.—Front view of the same boy as in Figs. 452, 453 and 454 after operation on lip for the purpose of shortening the lip; effecting reattachment of the parts in more nearly normal relation, and the removal of scar tissue. The improvement in expression of eyes is due to correction of unnatural muscular action.

FIG. 456.—A young man whose lip was operated upon in early infancy without due consideration for developmental principles.

FIG. 457.—The same individual shown in Fig. 456 after operation upon the lip and readjustment of the deformed parts.

FIG. 458.—Characteristic scar with notch following harelip operation.

FIG. 459.—Same young man shown in Fig. 458 after correction of the lip defect and closure of a wide fissure through both hard and soft palates.

FIG. 460.—A typical result from compression and injury to the premaxilla in closing double harelip fissure in infancy by the method of carrying flaps across under the philtrum as commonly advocated.

FIG. 461.—The same young man (twenty-two years old) who is shown in Fig. 460 after operation to correct the form of the nose, remove scars and readjust the lip outline.

FIG. 462.—Young woman whose face, nose, lip and mouth have all been deformed by displacement of tissue in an operation for double harelip performed in infancy.

FIG. 463.—Same young woman shown in Fig. 462, after parts have all been restored to their normal situations, and the scars removed. More than all else correct muscular action and respiration have been established. Through these agencies there has been a continued improvement in her features and the expression of the face.

A Thick, Broad, and Grooved Triangular Cartilage of the Nose.—When this is such as to be unsightly it is necessary to remove a certain amount of the cartilaginous tissue to give the nose its proper shape. The removal of this cartilage should be effected from within the nose

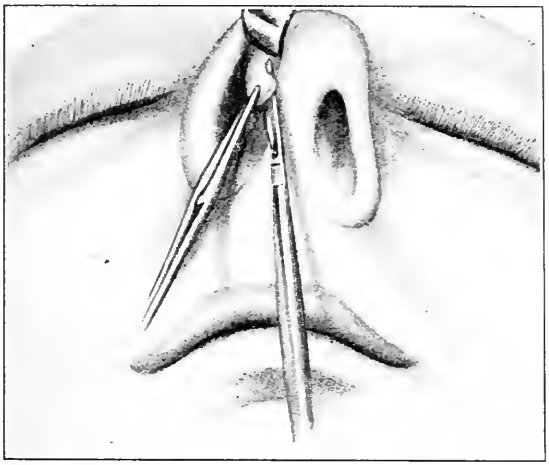


FIG. 464.—Shows the method of removing the excessive tissue from the triangular nasal cartilage in such cases without external incisions. Thus avoiding scar disfigurement.

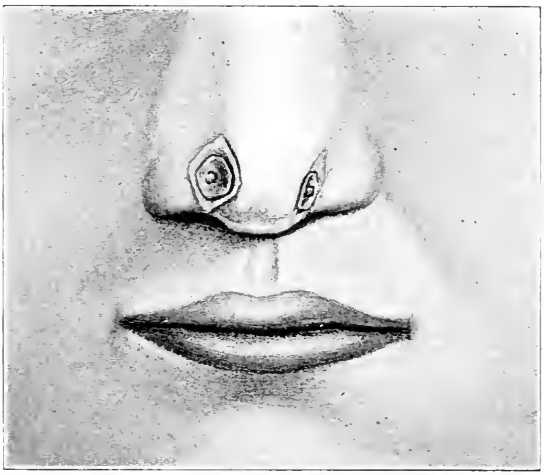


FIG. 465.—Fixation suture in place.

with fine cutting knives and a fixation suture passed completely through the nose from one side to the other, to hold the parts in form until union can take place. This is a common deformity among adults who were operated upon according to old methods of treating harelip

and is frequently required to give satisfactory results from harelip correction.

The author has operated upon large numbers of these noses, and the results are usually very satisfactory.

Situation of Scar.—When choice can be made as to the situation of the scar following lip operation it should be remembered that with boys it is best upon one side. If a double fissure has existed, both scars should be kept well away from the center, so that in later life a moustache may be grown which will cover the defect altogether. With girls or young women the line of union is less noticeable in the center, through the philtrum of the lip or along one or both of the ridges at each side of the philtrum.

FIG. 466.—Notch and scar from imperfect harelip operation in infants.

FIG. 467.—Same man shown in Fig. 466 one year after the correction of the lip defects by operation to lengthen the lip and obliterate the notch, as well as to reduce the scar.

Actual photographs of cases operated upon by the author according to the methods advocated are illustrated in Figs. 373 to 410, and 433 to 463 inclusive.

These pictures are intended to show that the results are uniform. They are presented in considerable number and variety for the purpose of demonstrating the clinical, therefore essentially practical value of the principles which underlie the operative steps that have been recommended.

SURGICAL TREATMENT OF CLEFT PALATE.

Definitions.—Uranoplasty.—Plastic surgery of the palate; any plastic operation for the cure of cleft palate; usually applied with reference to the hard palate.

Uranorrhaphy.—The surgical closure of a cleft palate, especially a hard palate.

Staphylorrhaphy.—Surgical closure of cleft palate, especially of the soft palate.

The author prefers the use of the terms uranoplasty and uranorrhaphy in the description of operations for the closure of the hard palate, staphylorrhaphy for closure of the soft palate, and the term uranostaphylorrhaphy for closure of fissure of the hard and soft palates.

Present methods of palate closure are necessarily founded on the groundwork constructed by eminent surgeons who have contributed to literature the results of their efforts in this direction. Lemonier, in 1776, was probably the first to attempt to close palate fissures by surgical means; he was followed by Eustache in 1799, von Graefe in 1876, Roux in 1879, Warren, of Boston, in 1820. Diffenbach, Liston,

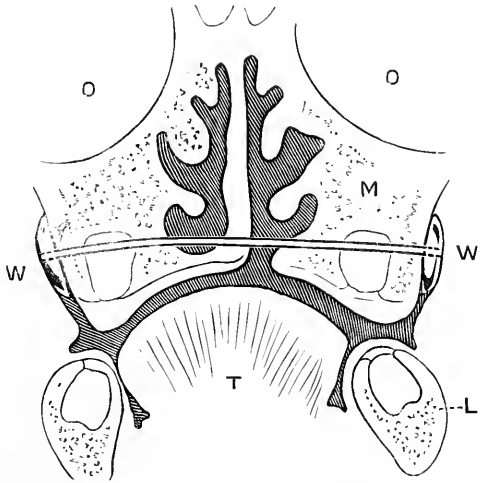


FIG. 468.—Brophy's method of wiring for cleft palate: *O*, orbital cavity; *M*, upper jaw; *L*, lower jaw; *T*, tongue; *W*, *W*, silver wire (note its relation to the teeth sacs which must be damaged).[1] (After Treves.)

Sir William Ferguson, Sedillot, Pancoast, William Garretson, Wolf, Erdman, Billroth, von Langenbeck, Trilet, and a host of great surgeons, past and present, who, despite great discouragement—for this work is ever discouraging to surgical procedures when compared with other fields of operation—have each lent some share of personal skill and ingenuity to aid the perfection of the operative technic necessary to insure the ultimate success of the work.

Necessary concentration of the results of study of the literature of cleft palate operation prevents detailed consideration or mention by name of many other authors who have from time to time brought forward suggestions with regard to these operations.

[1] Treves: Operative Surgery, Fig. 281, p. 173.

Types of Operation.—The recognized distinct types of operation from which one may choose in deciding upon a method of palate closure may be summed up as follows:

Compression.—By this is meant crowding together the segments of a palate divided by fissure in such a manner as to force the parts into contact. This method was recommended for young infants by Garretson and Brophy (Fig. 468).

Turning over the Flaps.—The soft tissues upon one side of the palate surface are reversed and attached to the opposite side. The method is recommended by Lane for young infants, and by Ferguson, of Chicago, for persons of more advanced age (Figs. 469 to 472).

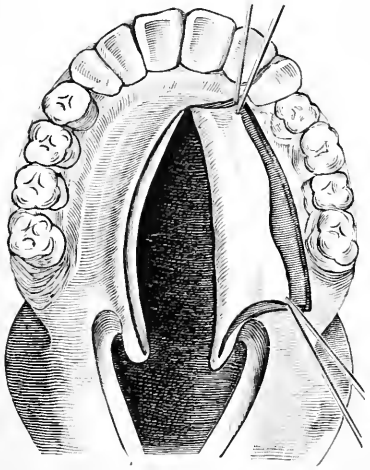


FIG. 469.—Lane's method of removing mucoperiosteal flap from hard and soft palate upon one side of the cleft, and tucking the edge of this flap under the mucosa through a slit upon the opposite side of the cleft. (After Eastman.)

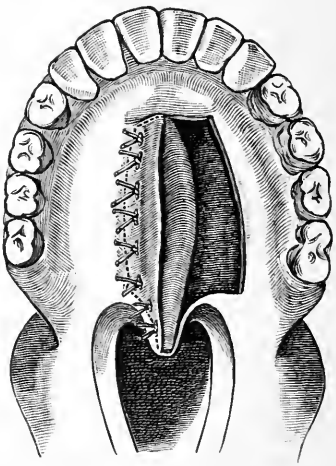


FIG. 470.—Edge of flap tucked under slip upon opposite side of cleft and sutured. (After Eastman.)

Carrying in and Attachment of Outside Flaps.—The flaps are taken from lips, cheeks, skin, or other extrapalatal surfaces, and the attachment of a finger or other expedient of this character is designed to bridge the fissure.

Fracture of Palate Bones.—This method consists in sawing through the palate bones from behind forward, fracturing with forceps, and wiring in such a manner as to approximate the bony fragments sufficiently to bring the soft parts together. It was devised by Ferguson, and earnestly advocated for many years by J. Ewing Mears, of Philadelphia, who did so much for the advancement of oral surgery, which after having become practically obsolete, was improved by Roe (Fig. 473) who by the use of a specially formed needle holder and needles was able to introduce an E string banjo-wire suture in such manner as secured very good results.

Anterior Ends of Flaps Detached.—Detachment of a flap from the anterior portion of the palatal mucoperiosteum and carrying it across the fissure, as advocated by Davies-Colley (Figs. 474 to 476), has undoubtedly a field of usefulness in certain cases.

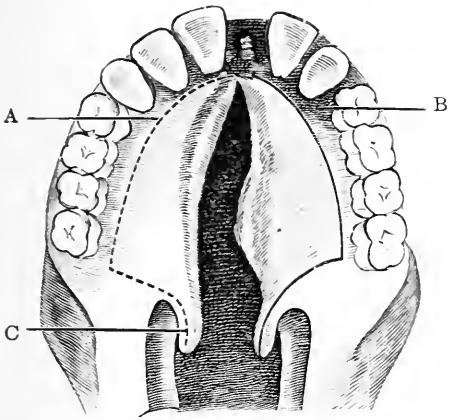


FIG. 471.—Ferguson's method: *A*, incision upon nasal side of palate for turning down flap; *B*, incision upon oral side for loosening of mucoperiosteal flap. (After Ferguson.)

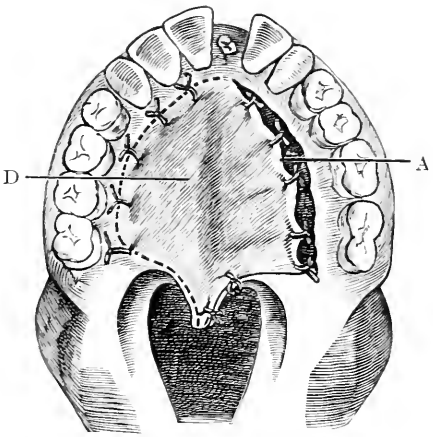


FIG. 472.—Ferguson's method; the nasal and oral mucoperiosteal flaps with raw surfaces apposing, leaving a mucous covering upon nasal and upon the oral side of the new palate. (After Ferguson.)

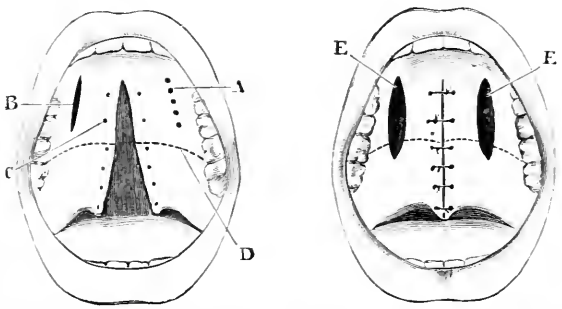


FIG. 473.—Fissures of the hard palate: *A*, preliminary punctures with awl to give line for chisel; *B*, incision through bone completed by chisel; *C*, holes bored through hard and soft palates for sutures; *D*, junction of hard and soft palate; *E*, lateral openings subsequently filled up by granulation.[1] (Bryant.)

Mucoperiosteal Flaps.—They are closed by lowering the palatal arch and sliding the flaps on the bone surface in such a manner as to bring them in contact, as brought forward by von Langenbeck, and improved and altered from time to time by other operators; this method may be useful.

[1] American System of Dentistry.

Retention Sutures and Appliances.—Subdivisions of these methods bring us to the consideration of various expedients for aiding the retention of sutures, such as the tape-ribbon of Mayo (Fig. 477), the wax tape-ribbon of Sherman (Fig. 478), the lead-plate and silver-wire attachment of Brophy, rubber or aluminum plates for protection of

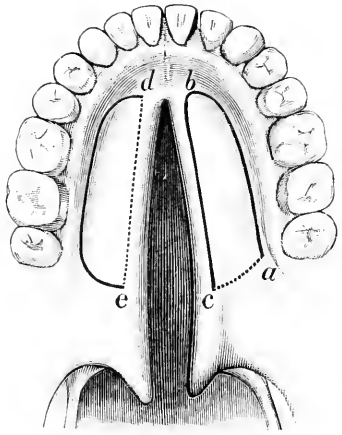


FIG. 474.—Davies-Colley operation for cleft of the hard palate with flaps (*a*, *b*, *c*, *d* and *e*) marked out.[1] (After Treves.)

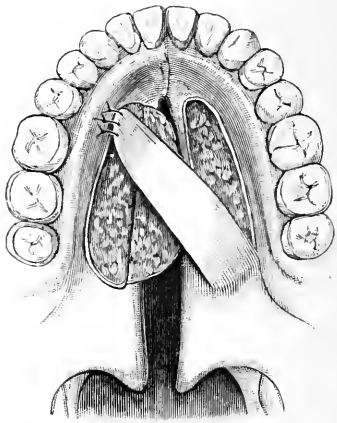


FIG. 475.—Davies-Colley operation for cleft of the hard palate. Flaps in position. (After Treves.)

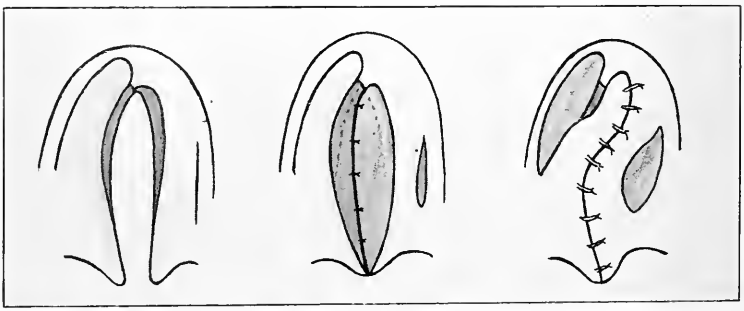


FIG. 476.—Mucoperiosteal flaps are turned inward to cover the fissure and sutured with the periosteum upward toward the floor of the nose. Another flap is raised with anterior end free and its posterior end attached by a pedicle, this is carried across the palate and laid with its raw surface upon the previously attached flap and united to a flap carried from the opposite side. (After McCurdy.)

the palate, as recommended by several writers, silver plates and wire as used by the late Dr. Fillebrown and modified by other operators.

Conclusions.—The author's consideration, observation, and experience, as applied to selection from these methods, lead to the following conclusions:

[1] Treves: Operative Surgery, p. 169.

Palate Compression.—The first of these methods is unhesitatingly to be condemned. Such compression necessarily contracts the parts in such manner as to narrow the nares and crowd the erupting teeth out of place or totally destroy them. Thus it leads not only to later disfigurement through disarrangement of the dental arch, but also to loss of growth and development of mouth, nose and face, making impossible the best speech when adult life is reached, and preventing the fullest possibility of good appearance.

Unfortunately these cases, when apparently successful and so reported, sometimes in later years prove to be more seriously damaged than the unsuccessful cases in which the parts have drawn apart at an early date, and thus to some extent overcome the contraction.

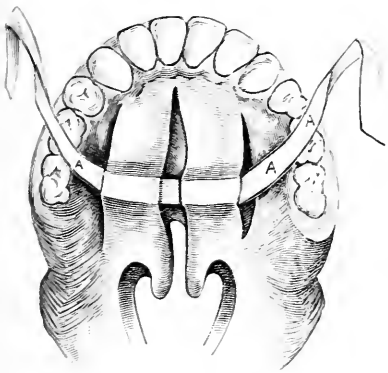


FIG. 477.—Charles Mayo's method. Unwaxed tape passed under flap. Tape is tied with single turn and secured by silk ligature. (After Eastman.)

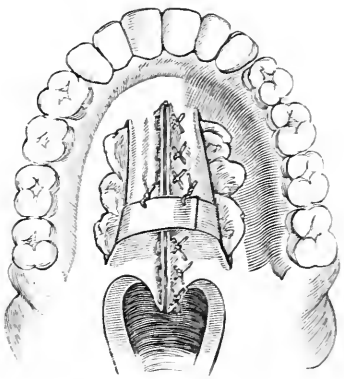


FIG. 478.—Sherman's technic, relaxation incisions, mattress sutures, tape impregnated with wax and iodine encircling the flaps to prevent tension upon sutures. Relaxation incisions packed with 5 per cent. iodoform gauze. The ends of the tape and silk ligature cut short and turned around to nasal surface out of reach of patient's tongue tip. (After Eastman.)

Large numbers of children and young persons who have had palates closed in early infancy by direct compression are living examples of the truth of this statement (see Figs. 441 to 449). Deviated nasal septa, contracted nares, and diseases attendant upon these conditions, extending in various degrees throughout the extent of the nasal mucous membrane; affections of the middle ear; mastoiditis with associated deafness; contracted palates with teeth developing toward the central portion of the mouth, with almost hopelessly deformed dental arches and insufficient space for tongue movement in speech, fully attest the truth of this conclusion.

Operation on Puppies.[1]—Additional evidence is given by sections through the heads of puppies aged six months. They have been sectioned so as to show definitely and with absolute perfection exactly what does occur in alteration of intranasal form when growth of the upper maxillary bones is arrested so as to interfere with the normal width across the palate. It is immaterial whether it occurs through adenoids, enlarged tonsils, mouth-breathing, the malocclusion incidental to irregular dental arches, or through forcible compression and the introduction of retaining wires or otherwise. In greater or lesser degree the same results are inevitably produced, and there is the invariable chain of pathological conditions which affect not only the local structures, but general health and development as well.

Much less compression was applied than would under any possible condition be necessary to force the sides of a palate fissure in contact with cleft palate cases. Therefore the ill-results which are apparent in the sections in the heads of these dogs (see Figs. 362 and 363, p. 566) might reasonably be expected to be much greater and more disastrous from such palate operations than with this slight compression.

Flaps Inverted.—The second type of operation (Figs. 469 to 472) the author also believes to be objectionable. The disturbance of the natural anatomical arrangement of the tissues, occasioned by turning the periosteum upside down, is hardly likely to cause bone growth to take place, as it might if the periosteal surfaces were merely moved across and brought together in natural position. He believes that all such operations, even though successful in giving a covering to the palate, cause formation in that region of more or less thickened fibrous tissue. While this tissue may yield to normal expansion as growth proceeds, and thus not seriously contract the width of the palate or nose, when developed it will not have the firm, resounding properties of a bony palate, nor will it have the fixed resistance to the attachments of the muscles that is necessary for proper speech function.

The author's belief is founded upon observation of a considerable number of cases in which there was not and never had been fissure through the palate, beyond a few instances of bifid uvula, and yet these individuals had all the speech defects of patients with complete fissures through both hard and soft palates. Not only was this the case, but the inability to profit by speech training seemed to be fully as great. Careful examination disclosed in every instance that though union of the soft tissues of both hard and soft palates was complete, there had been an arrested development of the palate bones. This left the hard palate short or with the outlines of a notch in the median portion, which would have been a cleft palate had it not been covered by soft tissue. Such cases were not previously, and are not now generally recognized, as is evidenced by the fact that in several instances more or

[1] For description see page 564.

less persistent electric and other treatment had been used to stimulate what was believed to be an insufficient action of the palate muscles due to partial paralysis. As a matter of fact, the real cause lies in the alteration of the fixed attachments of the muscles of the velum palati at the hard palate, so that proper function in lowering and raising is impossible, and for this reason development of the soft palate as a whole is incomplete. Operation in a number of these patients has led to considerable improvement, but the trouble is so insidious and yet so difficult to overcome that any operation which at the outset contemplates producing a similar condition should be avoided.

Transplantation of Tissue.—The introduction into the mouth of extraneous tissue of any character is now known to be absolutely unnecessary. Even the worst forms of palate fissures can be closed without resort to such expedients and with better hope of function than would be possible even if operative attempts at transplantation had been more successful.

Methods of Retention.—In the selection of methods of retention such as are included in our subdivision, the author's experience leads to the conclusions that certain principles must be observed in all palate operations, and that without provision for them no retention expedient can be successful. If these operative principles are duly provied for, it makes little or no difference how retention is accomplished or what agent is used. A plan which may be successful for one operator may in no way appeal to or be productive of good results for another. A mucoperiosteal flap, unless relieved of the chief elements of tension by operative means, cannot be successfully held by any retention appliance, suture or other similar assistance. If there be tension upon the sutures, they will tear out; if there be undue strain upon a broader surface which cannot tear out, there will at least be pressure which will interfere with circulation and cause sloughing; thus the result is likely to be the same.

Rubber or aluminum plates, or other similar appliances to protect against pressure after operation, are quite unnecessary and should be avoided on the ground that all things that may be cumbersome, uncomfortable for the patient, or difficult to keep clean are contraindicated. Lead plates kept for any considerable length of time in mouths of patients are not desirable; moreover, the covering of large surfaces of mucous membrane of the mouth by any substance which prevents cleanliness is inadvisable.

The author's conclusions as affecting operative methods may be summed up in the statement that the real basis for improvement in the results of palate operation lies not so much in a new method as in the perfection of technic and the steps of operation, so that the purpose toward which all the different plans are directed might be better accomplished.

Throughout all cleft palate treatment, from the first care of young infants until the final closure, whatever the age may be, the nasobuccal

relation should be a foremost consideration, for upon favorable nasal conditions both speech and development depend.

Decision as to the Method of Procedure.—If, therefore, the surfaces of the palate of an adult on each side of the cleft are broad enough, and the angle of their slant sufficiently acute to enable the borders to be brought together in the median line without tension, after making due allowance for incisions, then a plastic operation alone is indicated. If these conditions are unfavorable, then the bony parts should be corrected before the division in the soft tissues is closed.

Reduction of Wide Palate Fissures by Maxillary Operation.—Since direct compression without modifying preparation would narrow the nares, the author has devised the method shown in Fig. 479. By

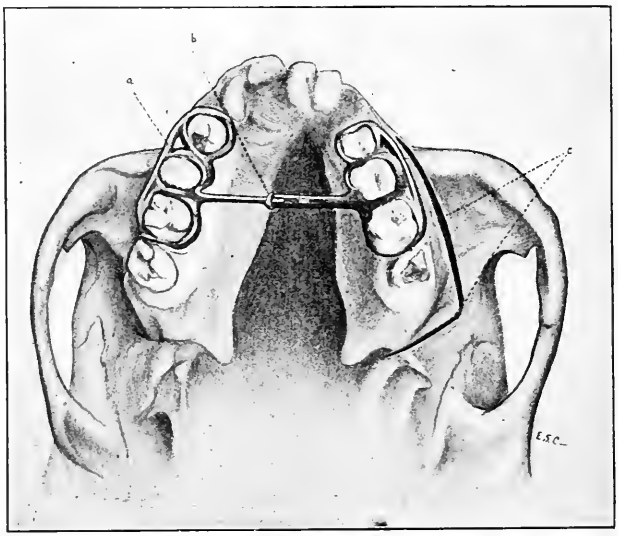


FIG. 479.—The author's method of bone operation to reduce the width of unusually unfavorable fissure: *a*, *b*, nut and screw bar, and bands cemented upon the teeth; *c*, lines of cutting to weaken the bow resistance. It is only in very unusual cases that this treatment is required.

cutting through the malar ridge on the external surface of the upper maxilla, and again behind its tuberosity, with additional grooving of the bone through the denser external wall between these points (Fig. 479), the parts will yield under pressure and narrow the palate fissure without affecting the nasal region to any marked extent. The form of splint shown in Fig. 479, *a*, *b*, holds all parts firmly as long as required to give security. Fig. 497 is a photograph of the mouth of a patient after this operation has been performed, and shows the splint in place.

Operative Essentials in Palate Closure.—The chief considerations to be observed in uranoplasty and staphylorrhapy are: (1) Position of the patient; (2) anesthesia; (3) control of immediate hemorrhage; (4) provision for control of secondary hemorrhage; (5) access to field

of operation; (6) avoidance of injury to tissue, particularly the periosteum; (7) preservation of blood supply; (8) relief of tension; (9) character and adjustment of sutures; (10) control of adverse muscular action; (11) prevention of septic conditions; (12) preparatory treatment; (13) postoperative care.

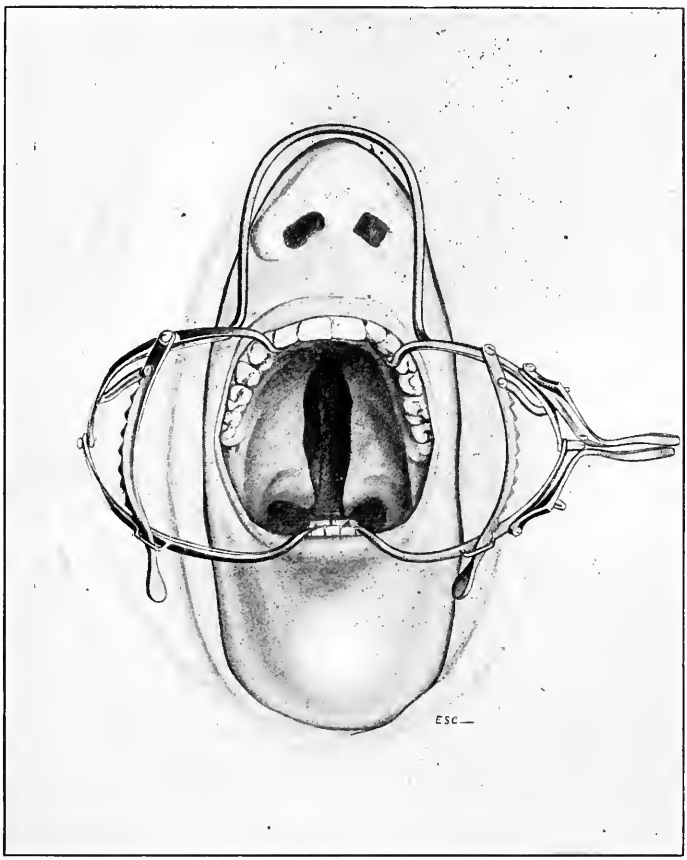


FIG. 480.—Cleft through hard and soft palate. Whitehead's mouth gag as modified by the author with bar across the front of the mouth removed, bow over the nose and arms clasping the teeth on each side.

Position.—With the patient in a recumbent position and the shoulders raised with a pad, the head tipped backward and to one side, a good view of the field of operation is obtained; blood collects in the pouch formed by the pharynx where it is least likely to be inspired and most easily cleansed. The author finds this more favorable than the Rose position, in which the head hangs over the table, because the parts are viewed directly, and this makes it easier to get correct approximation than if viewed upside down. Moreover, patients sometimes

complain of much discomfort from the neck muscles after long operations when the head was hung over the table and not been properly supported.

Anesthesia.—Ether, vaporized by heat, and blown through a tube into the back part of the mouth, as by the Gwathmey apparatus (Fig. 13, p. 33) can be made to give just the delicately poised anesthesia that is so exceedingly desirable to avoid the danger of blood inspiration,

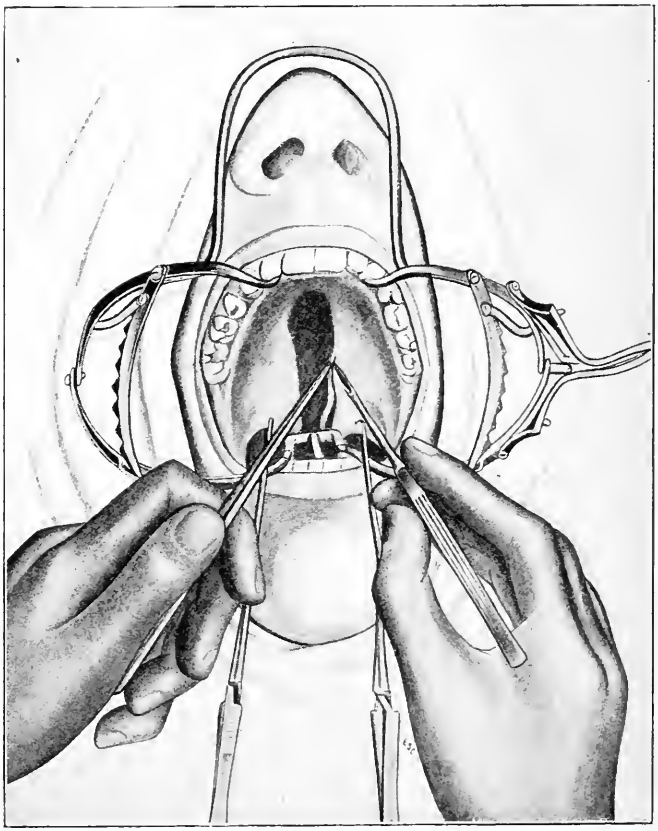


FIG. 481.—The author's self-retaining fixation forceps attached to hold the soft palate taut to favor perfect operative work upon the fissure border. Paring the border of the fissure. The author believes that a palate border pared and split is more dependable for a secure line of union than one split and not pared.

which might easily occur with the reflexes entirely abolished in profound unconsciousness. This method also makes it possible to keep a patient on the border-land, sufficiently quiet and insensible to pain, with a minimum of danger and of tendency to postoperative or other ill effects of the anesthesia.

Access to Field of Operation.—To obviate the disadvantage of the bar across the Whitehead gag, which interferes with work in the anterior

part of the mouth, the author has had this gag improved by removing the objectionable portion and substituting two arms which rest upon either side of the palate close to the teeth. They occupy practically no space, hold the appliance rigidly in place, and leave the entire field absolutely free (Figs. 480 to 488).

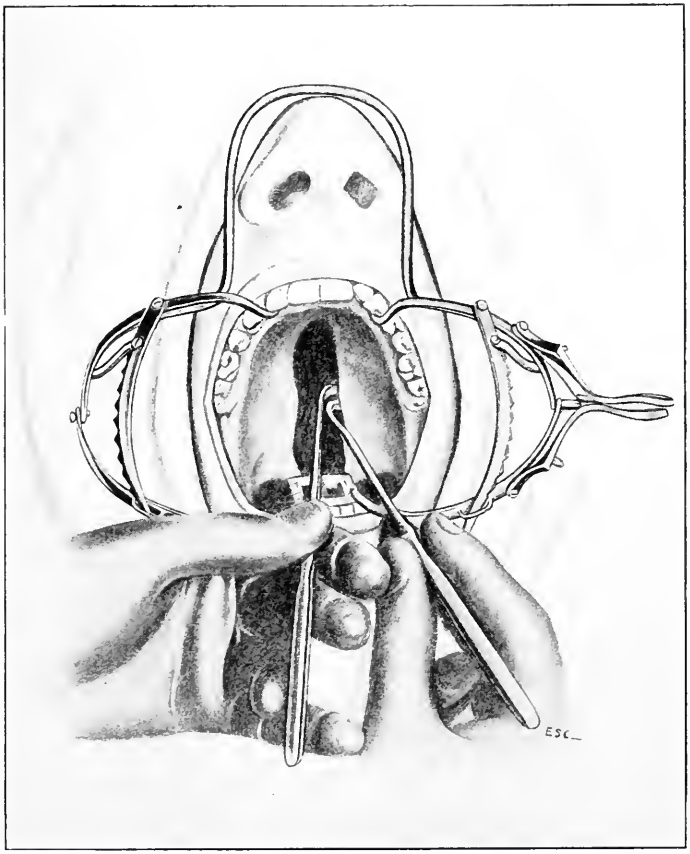


FIG. 482.—Raising the mucoperiosteum with the author's periosteal elevator, the knife being passed under it to sever resisting attachments.

The tongue holder attached to the gag is to some extent adjustable, since patients at different ages and sizes require tongue holders of different lengths.

Another improvement is the addition of two little parts that slide down over the horns that rest against the palate. These additions make the gag fit the mouths of exceedingly young infants, and the guards upon each side give a very desirable degree of steadiness (see Figs. 489 and 492).

Preservation of Blood Supply.—Perhaps no part of staphylorrhapy or of uranoplasty requires so much judgment as the decision with regard to sufficiency or insufficiency of vascular supply to sustain the tissue when carried to its new position.

If the operator does not do an extensive and radical operation involving the free loosening up of all tissue upon the palatal surface, he is almost certain to suffer failure through pulling apart of the wound

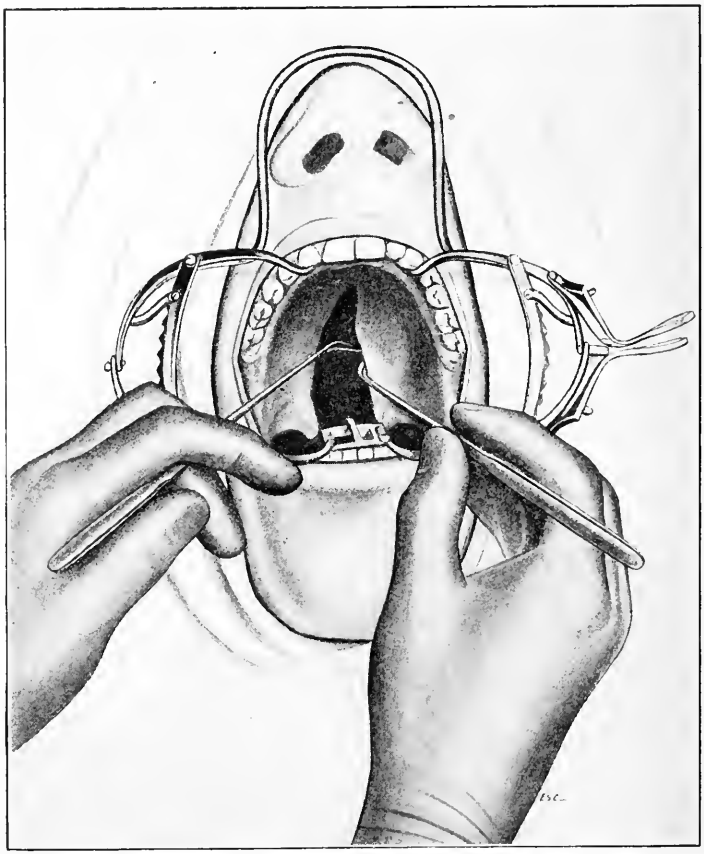


FIG. 483.—Mucoperiosteum raised while the author's knife, safe on the upper side and bent to a suitable angle, is used to sever the tissue attachments at the posterior border of the hard palate.

surfaces. If, on the other hand, he does his work very thoroughly, making free incisions, and completely separating all tissue adherent to the palate surfaces, the danger confronts him of having extensive sloughing through want of nourishing blood circulation. Great care and judgment are also required to avoid undue injury to vessels. Plate I (frontispiece) is designed to give accurate guidance in dealing with all important anatomical structures in this region.

Tension Relief Incisions.—Incisions in line with and near the gingival borders of the palate upon each side should, if possible, be above the line of the palatal artery, and in using the periosteal elevator it should pass under the vessel, and effort should be made to raise it intact, so that there may not only be less hemorrhage, but better circulation in the flap as well (Fig. 484).

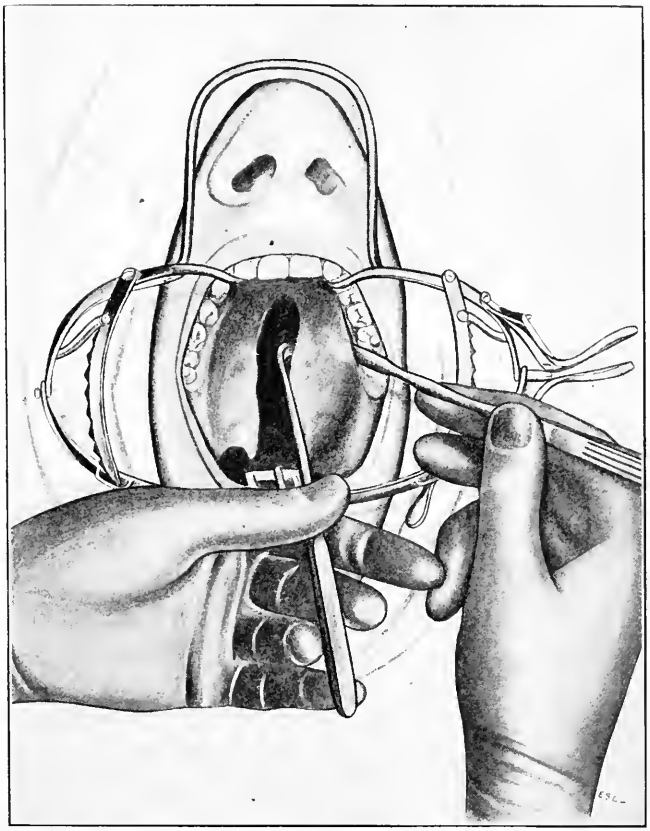


FIG. 484.—A straight periosteal elevator passed through the lateral incision under the mucoperiosteum, and a curved one simultaneously forced from the border of the fissure to raise the flap with the least possible traumatic injury.

It is not always practicable to do this, especially where cases have been previously operated upon and the parts disarranged, but it should be borne in mind and accomplished, if possible. In the same way, the vessels passing through the foramina at the anterior palatine fossa should not be severed in the effort to separate tissues from the bone in that region.

These incisions are only called for in more or less extreme cases.

Objections that have been made to this plan of relieving tension

fall to the ground when confronted with conditions in which through scarcity of tissue failure must inevitably result unless the tension be relieved.

Incisions upon each side of the soft palate should be a series of slight incisions in the same line, with the tissue held on the stretch, rather than a single deep continuous incision which would increase the danger

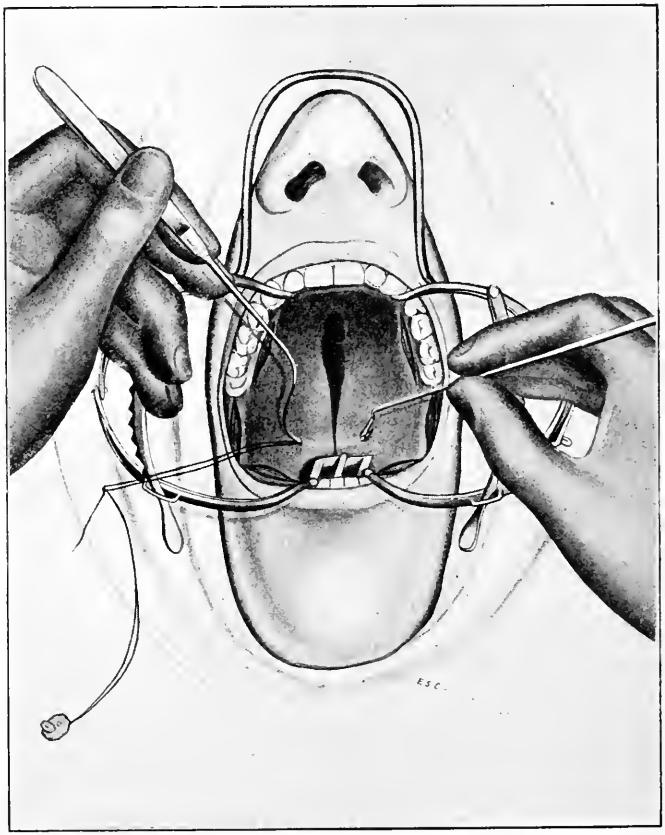


Fig. 485.—The author's method of inserting the principal wire retention suture. The illustration shows the bronze wire suture with silver plate, attached to the leading suture as inserted with the author's needle and caught at the point with a hook for this purpose.

of hemorrhage. Care should be taken to make these in such form that a packing, if it is necessary to insert one, would be retained and effective (see Fig. 486).

Sutures.—The author uses formalized pyoktanin gut for coaptation sutures. He has found it better than silk, inasmuch as it does not take up the oral secretions, and, though resisting for a sufficient time to serve its purpose, it is easily absorbed, and unlikely to make a channel

down which the nasal secretions can find their way and thus create infectious disturbance.

Retention sutures are of silkworm gut or as formerly used aluminum bronze wire. This the author believes to be preferable to silver wire, because it has a slight degree of stiffness which prevents its pulling taut and in that way cutting the tissue at each side. This wire is passed

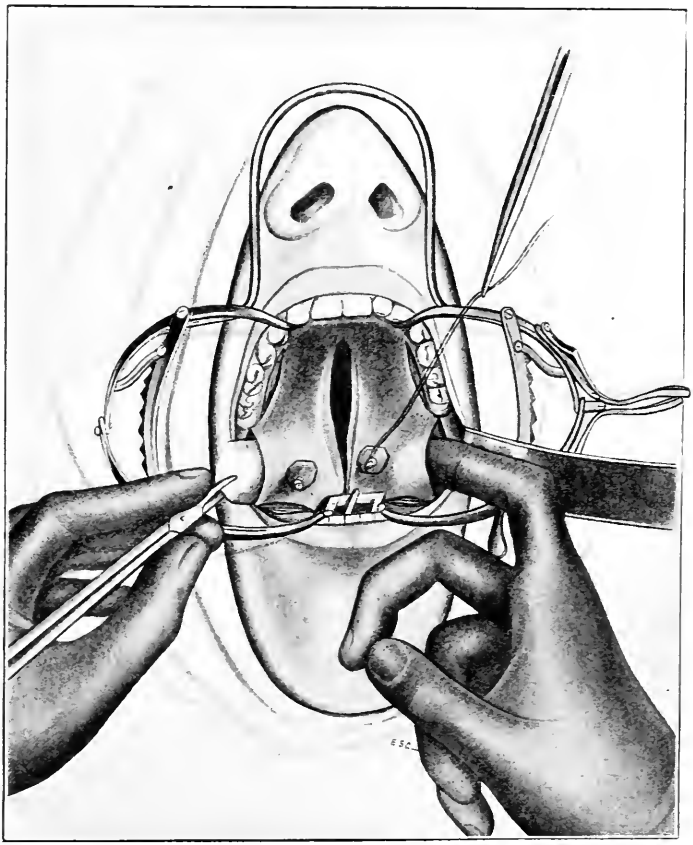


FIG. 486.—Wire tension suture in place with silver plate slipped over its free end down to the palate surface and followed by four lead shot. Method of freeing the soft palate tissue, and forcing it toward the center through the lateral incisions. Pad inserted as used to control hemorrhage.

through silver plates which serve to relieve the tension. No matter what the form of plate or button suture may be, it is well to remember that, after all, the wire itself would cut through the tissue if any considerable amount of strain were placed upon it. While the silver plates covering a broad surface upon each side do assist in this respect, these sutures, or any other similar ones, do not give absolute security against tension.

The fact, however, that a plate upon each side of the palate makes it unnecessary for the wire to cross the palate again, thus leaving the tissue free, reduces the danger of cutting out very considerably, and does not interfere with circulation, as it otherwise might (Figs. 486, 487 and 488).

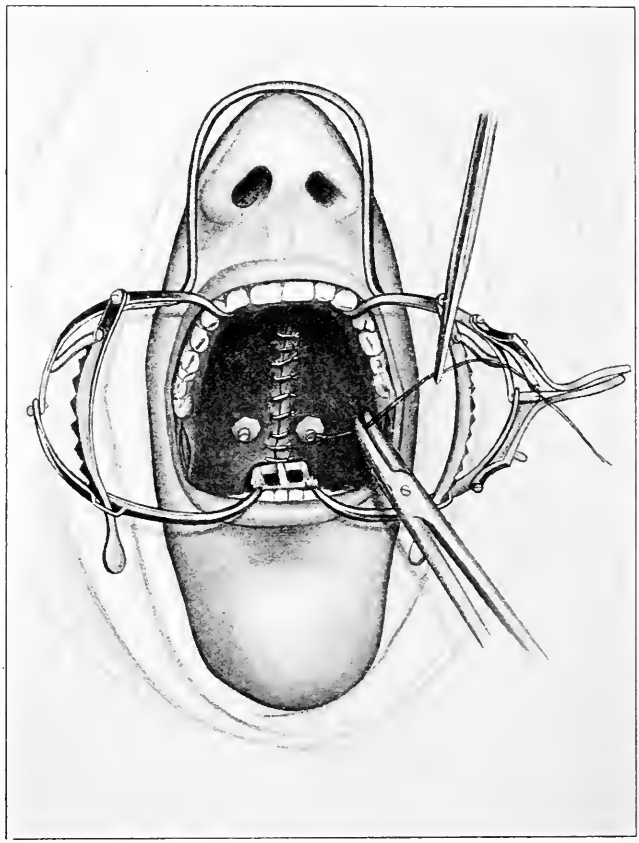


FIG. 487.—Fissure borders coapted with pyoktanin gut and horse-hair sutures. Tension suture in place and the last shot being compressed to hold the plates.

The sutures, as the author inserts them, are a modification of those used by Dr. Fillebrown, who first called his attention to the use of the silver plates. The change that has been made is in the use of perforated lead shot, which are slipped over the wires and pinched down upon the plate (Fig. 487). By using a series of four of these, they can be readjusted and tightened a little from time to time, as the operation progresses. Thus the exact pressure on the retention plates and the resistance they have to overcome are easily and accurately adjusted.

During recent years the author has used silkworm gut almost entirely instead of wire. It has been found to be much more easily handled than any kind of wire, and is quite as reliable for this purpose in every way. It is used with the silver plates, and shot the same as described for the wire suture.

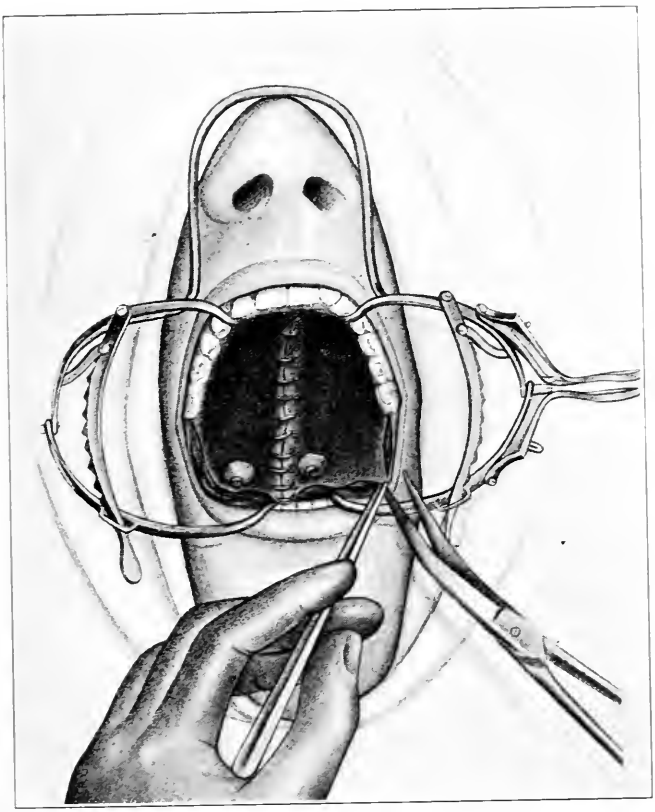


FIG. 488.—The operation completed and the final clipping of tension causing fibers being made to give not only freedom from tension but a broader palate surface for better speech purposes. Relief incisions such as are shown in this illustration are only required in comparatively rare cases in which the tissue is very scant.

Author's Operation.—The method of operation is shown in Figs. 480 to 488. It covers quite closely in a general way what might be known as the old method of performing staphylorrhapy, with certain modifications which have from time to time been adopted.

Separation of Mucoperiosteum.—If in the separation of the periostium from the bone surface the membrane of the overlying tissues which form the mucoperiosteal flaps suffers undue traumatic injury, the danger of sloughing is very materially increased. In order that this may be accomplished with as little bruising or damage as practi-

cable, the author has had his own periosteal elevators made for delicate manipulation. These are in different sizes and angles, with very smooth, slightly convex surfaces (see Figs. 491 and 492, *C, C, D, E, F, G, H, I*). The reason for this is that palates not only differ in size, but also have different angles, and even slight force applied in a direction which would easily separate the periosteum from the bone in one case might bruise, tear, or break it with serious injury in another. By having the angle of the instrument regulated to the slope of the palate wall, this difficulty is to some extent obviated and more delicate manipulation made possible.

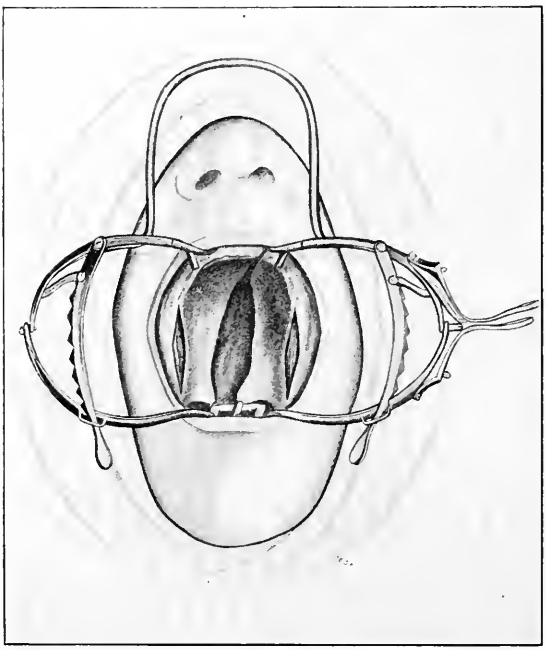


FIG. 489.—The author's method of palate operation for infants. The attachment slipped through the arm of the modified gag clasps the anterior part of the alveolar ridge as shown. The incisions as used for these cases are as described.

It is frequently necessary to cut the bands of scar tissue and unusually resisting attachments that prevent the periosteum from being lifted easily. This difficulty is overcome by a set of knives with angles corresponding to the form of the periosteal elevators, so that, with the elevator making tension upon the tissue, the knife can be passed under it (Fig. 482) with perfect safety and be depended upon to cut the resisting attachment without inadvertently damaging the periosteum (Fig. 492, *K, L, M, N*).

Needles.—The needles are of different curves, shaped something like a corkscrew, so that when passed in upon one side it can easily be

calculated where the point will show upon the other (Figs. 491 and 492). With these the author finds it possible to work at greater advantage than with a needle holder, because his hand is not in the way to obscure the line of vision.

Postoperative Changes in Palate Form.—Observation of the changes that take place in the form of palates, both hard and soft, not only during the first few weeks immediately following closure of clefts by operation, but during at least several years afterward, brings to notice a number of facts that should have a direct bearing upon operative procedures.

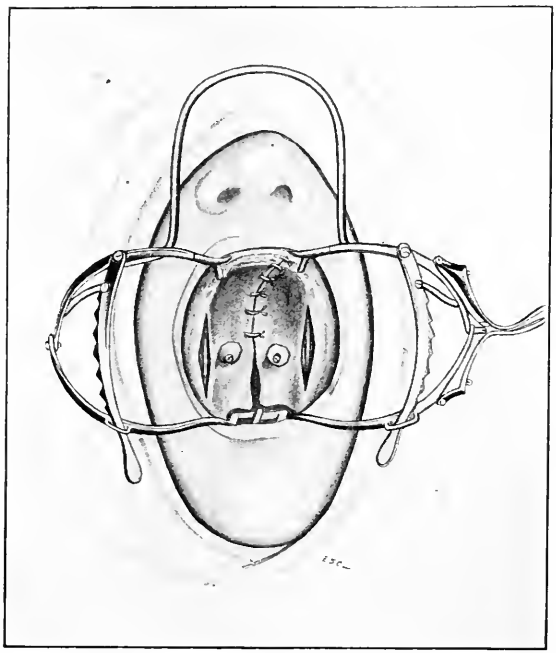


FIG. 490.—The hard palate closed and the tissue of soft palate brought close together but not sutured as advocated for infants when the hard palate is cleared first, and the soft palate one year later as described in the text.

The first strain upon sutures occurs at the time of the operation, when the flaps are moved over to be brought into contact. If properly relieved and the sutures securely placed, this quickly disappears. In natural order it occurs that the healing of the incisions made to relieve tension, and the tension of the flaps which have been brought down from the bone surfaces caused by the periosteum seeking its normal situation, gives rise to a tendency to pull apart in the median line, which, if unanticipated, is very apt to bring disaster just when the surgeon is beginning to congratulate himself upon success.

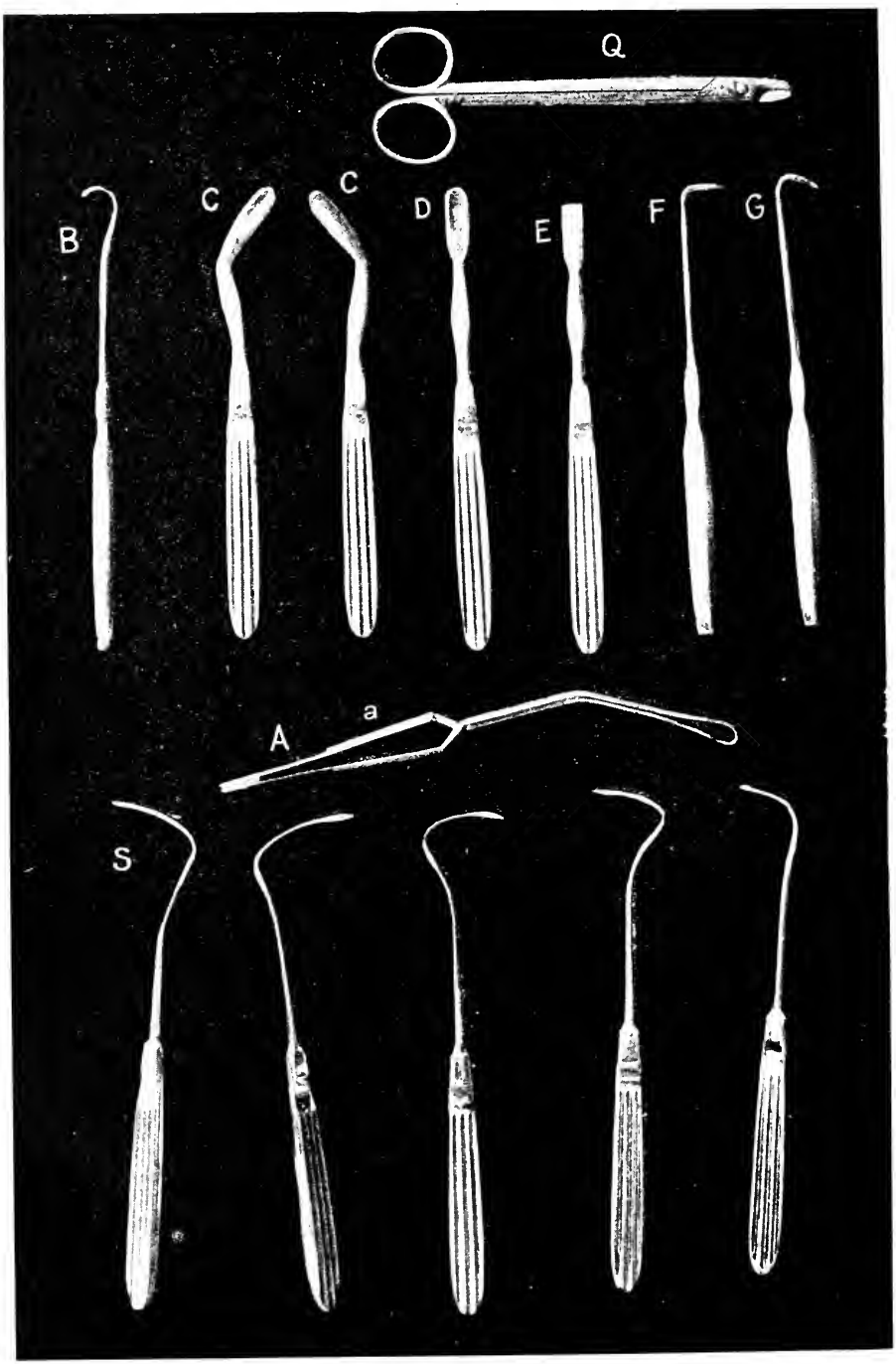


FIG. 491.—The author's set of staphylorrhaphy instruments: *A*, self-retaining tenaculum forceps for holding the soft palate taut; *B*, retractor; *C*, *C*, right and left periosteal elevators; *D*, *E*, *F*, *G*, periosteal elevators; *Q*, wire cutter; *S*, needles.

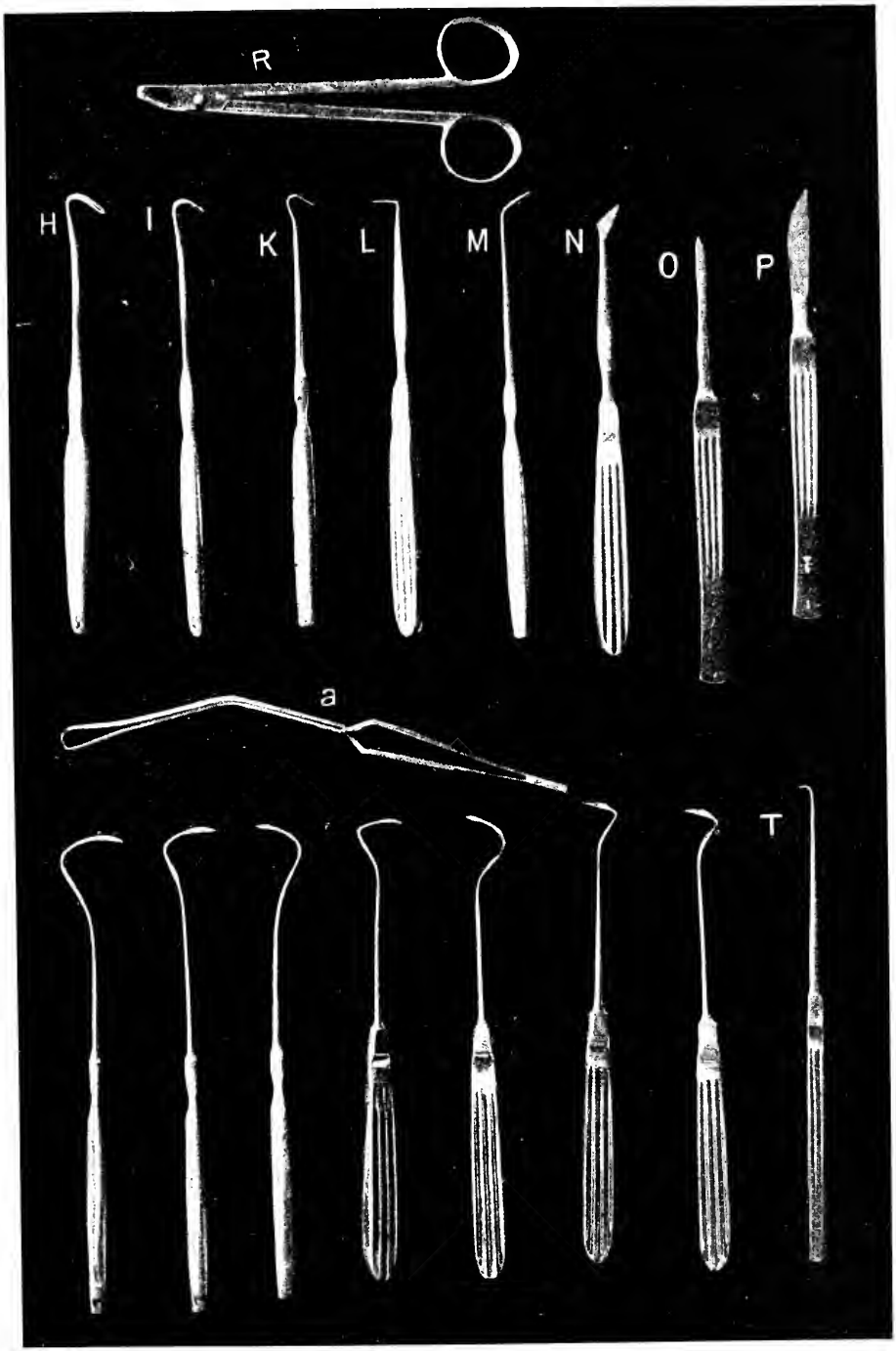


FIG. 492.—The author's set of staphylorrhaphy instruments: *a*, self-retaining tenaculum forceps; *H*, *I*, periosteal elevators; *K*, *L*, *M*, *N*, knives of different angles; *O*, *P*, straight knives; *R*, lead shot compressor; *S*, needles of different sizes and curves; *T*, hook.

Many patients have come to the author with histories of previous unsuccessful attempts to have their palates closed. In them the operation appeared to be perfect for several days, and then the palate opened up again.

FIG. 493.—Palate view of typical case of double harelip and cleft palate showing the characteristic deformities of the nose and palate.

FIG. 494.—Photograph of girl, showing fissure in the velum palati.

FIG. 495.—Picture of mouth of the same patient as in Fig. 494 after operation.

FIG. 496.—Photograph of the mouth of a patient with cleft through both hard and soft palates.

Ten days to two weeks is about the time during which retention must usually be provided for, before all sutures can safely be removed.

From this time on, during several months, there is a gradual rounding of the palate surface, the arch becoming higher and the pillars of the fauces more directly outlined. Future form of the palate depends upon natural growth as influenced by respiration and its use in speech.

In nearly all cases the velum has much the same appearance after operation, but some of the author's patients who have made more than

FIG. 497.—Same patient as in Fig. 496, with the appliance used for reduction of the bone deformity in place.

FIG. 498.—Photograph after fissures through both hard and soft palates have been completely closed.

ordinary speech or vocal effort, and who have made the greatest strides toward speech improvement, have had their soft palates become lined

and creased by developing muscles, and have lost much of the smoothly outlined surfaces that were observed a few weeks after closure.

Among these patients, with ages varying from fourteen to fifty years at the time of operation, are a number who show almost no speech defect that would be noticed in ordinary conversation, especially among strangers, as an indication of cleft palate, yet the appearance of their palates would be disappointing if compared with others in whom the speech results are not as good.

The cause of this is that great effort is required to coerce the newly adjusted and but partly developed palate muscles to perform their parts in speech office, and unusual development is the natural result.

Muscular Alignment.—The lesson to us as influencing operative methods is to emphasize the necessity of perfect alignment with the uvula in the center, in order that the detached muscles at each side may form as perfectly outlined arches as possible, that the back of the tongue may find, as nearly as may be, the natural outline when it meets the posterior border of the palate, and the postnasal space be closed as readily as conditions will allow, and all muscles of the palatal region coördinate with at least reasonable perfection. Figs. 493 to 498 are examples of different forms of palate fissures and the results of operations performed by the author according to the methods here described.

SPEECH RESULTS OF CLEFT PALATE OPERATION.

In consideration of what may safely be promised to those who contemplate surgical operation for the closure of cleft palates, and the more or less complete correction of the defects from which such persons suffer, there are many elements that must be taken into account.

1. Above and beyond all else is the individual feeling on the part of those afflicted. No normal person can fully comprehend this. None can know what this means save those who have reached sufficient age to suffer the scoffs and jibes of school children, the heart-trying struggle to keep up in school or college with the handicap of imperfect speech, or the bitterness of social ostracism, even though largely self-inflicted through supersensitiveness, and the untold trials of wage earning or other battles of life in competition with the anatomically perfect though often less gifted mentally.

2. More healthy conditions of nose and pharynx mean, in greater or lesser degree, better general health, and particularly protection against deafness due to the middle-ear disease that so commonly results from unusual Eustachian exposure through open palate fissures.

3. No plates, obturators, or any sort of mechanical appliance could give either of the two foregoing benefits.

4. There is the infinite satisfaction of knowing that throughout life continued speech improvement is possible, and that whatever may be accomplished in this direction is permanent, not subject to

FIG. 499. — Illustration prepared to represent as nearly as possible the unequal division of the soft palate which frequently results from the destructive processes following imperfect early operations, and which makes operative conditions much more difficult.

FIG. 500. — Illustration representing the condition of the mouth of a boy, aged twelve years. His first operation was performed in infancy. Following this several other unsuccessful operations were made in attempt to close the palate fissure before he came under the author's care. The unequal muscular activity had been militating against success. This fibrous band of tissue was freed with the underlying periosteum and muscular readjustment accomplished when these openings were closed. The result is that at his present age, seventeen, this young man can speak almost without speech defect.

FIG. 501.—Cast of the mouth of a child, showing the contraction and loss of teeth from a compression in early infancy operation and the loss of tissue which makes closure exceedingly difficult.

FIG. 502.—Drawing from the cast of the mouth of a young woman, aged twenty-eight years. Palate was closed by compression in early infancy. Her upper dental arch is so narrow and the palate so high that the freedom of the tongue in speech is so inhibited as to make good speech sounds practically impossible. She has also a corresponding contraction of the nares with marked deflection of the septum.

uncertainties of accidental loss or breakage, or change in perfection of adjustment through absorption or growth of surrounding structures, with attendant difficulties of reconstruction; and necessity of again becoming accustomed to the new or altered appliance. All this must in the natural course be expected with artificial appliances, to say nothing of the cleanliness of natural tissue as compared with uncleanliness of plates under these conditions.

5. There is some degree of immediate improvement in speech, for almost invariably speech becomes easier and is effected with less effort; but beyond this, progress is dependent upon a number of modifying factors.

Conditions which Govern Speech Progress after Operation.—Postoperative results show that, although there is always more or less noticeable defect present in speech sound, some patients gain marked improvement almost immediately, and this with comparatively little conscious effort or speech training. In other cases voice change for the better is exceedingly slow and can be acquired only after long and patient effort. In considering the different factors that must necessarily play a part in this condition of results, one element of purely etiological character is of primary importance.

The Influence of Etiological Factors.—As previously stated, it is the author's custom wherever practicable to trace as accurately as possible the family history of each patient through at least three generations. In approximately 10 per cent. a history of direct heredity in the family appeared, and upon one side or the other ancestors affected by either harelip or cleft palate or both were found. The number in which maternal impressions play a part is so small as to be of little significance. Many of the stories told by mothers and relatives of shock, fright, or other maternal impressions during pregnancy when analyzed, are found to have occurred too late. Little thought is commonly given to these matters earlier than the fifth, seventh, or eighth week, and it is during this period only that this factor would be of etiological importance. Careful study of the family histories, however, quite often reveals the fact that relatives have been subject to mental peculiarities, nervous affections, diseases of the heart, aneurysm, tuberculosis, cancer, or paralysis. These and other affections occur with astonishing regularity. Usually there is comparatively little difficulty in tracing upon either the paternal or maternal side, and sometimes both, these evidences of an unstable nervous system and irregular or insufficient bodily or mental development which indicate arrest of development during the early embryonic period.

The bearing of this upon the subject is chiefly made apparent by an important fact which the author has been unable to find noted by other writers, but which he has so frequently met in dealing with these cases as to warrant mention.

By no means invariably, but quite frequently, he has noticed that

either the father or the mother of a cleft-palate patient had some peculiarity of speech. In none of these cases has the peculiarity been noticed or associated in any way with cleft palate, and though he has been unable to examine all cases, it is fair to assume that in the outward appearance of the palate there was no defect. Nevertheless, careful attention has demonstrated that there was unquestionably, in greater or lesser degree, tendency to nasal or imperfect speech sounds such as are more markedly noticeable with cleft-palate patients. It would seem, then, that there must be in these individuals either a nervous inefficiency in the speech mechanism or a slight imperfection of anatomical development, either of which in the next generation has become exaggerated into complete fissure and consequent speech difficulty.

Many persons whose palates are only slightly imperfect, the uvula being bifid and both velum and hard palate apparently complete, have marked speech defects. These cases are more specifically described under the heading of Speech Defects without Cleft Palate.

Significance of Corrective Influences in Embryo.—That Nature does repair both harelip and cleft palate in embryo is quite frequently demonstrated by individuals who have a mark extending the full length of the lip with notch at the labial border. Such lips have the appearance of having been imperfectly operated upon in early infancy, although no such operation has been performed, because the lip was in this condition at birth.

Speech Defects Directly Due to Postoperative Imperfections.—Observation of cases after operation, and particularly those in which, on account of imperfect operative methods, there has been little or no improvement, speech progress under training being slow, leads to the following conclusions in explanation of these difficulties in many instances.

Ill-advised Operations in Early Infancy.—Where forcible means have been employed in early infancy to bring the sides of the fissure into direct or too close approximation, the arrested development of the maxillary bones makes the anterior portion of the mouth too small for accomodation of the tongue in the utterance of word sounds. This disadvantage is increased by the fact of the early disarrangement of developing germs of teeth through forcible compression of the parts. Not only are the incisors, cuspids, and bicuspids erupted in such position as to reduce the size of the dental arch, but frequently one or more teeth erupt almost in the central portion of the palate.

Under these conditions, words beginning with *c*, *d*, *g*, *h*, *j*, *k*, *l*, *n*, *r*, *s*, *t*, *x*, *z*, all of which the tongue utters principally behind the teeth and with little or no assistance from the lips, are exceedingly difficult, if not practically impossible, to utter correctly.

Disarrangement of the anterior teeth, since the teeth are more or less involved in pronunciation of all letters, widens the range of defective sounds materially. Where any portion of the protruding premaxilla

has been removed for the purpose of facilitating lip closure in infancy the non-eruption of teeth in this region is also a very serious disadvantage.

Scars that stiffen and distort the lip, and which are so commonly noticeable on account of improper operative treatment in infancy, affect all words beginning with *b*, *f*, *m*, *p*, *v*, *w*.

Maldevelopment of Nasal and Other Parts Accessory to Speech.—Imperfections from wrong methods of early treatment, such as noses that have the characteristic appearance of leaning to one side, with the cartilaginous wing more or less flattened, usually have deflection of the septum with tendency to unequal development amounting to partial stenosis upon one or both sides, or one naris may be unusually large with corresponding enlargement of the turbinal bodies. Hypertrophy of the nasal mucous membrane and other pathological conditions that are in natural sequence to these conditions tend to nasal speech sounds even in persons otherwise normal, and are obviously disadvantageous when other speech difficulties incident to cleft palate speech habits act as a still greater complication.

Hard Palate too Short and too Flexible.—Shortening of the hard palate in its anteroposterior measurement, such as often occurs from wrong operative methods and failure to develop cartilaginous or bony tissue of sufficient firmness to act as a sounding board, or to give the degree of stiffness required for proper muscular action from points of attachment thereto, is a matter of much importance, since physiological action of the muscles of the soft palate depends upon the outline and character of the posterior border of the hard palate. Methods of operation by which the periosteum is carried over accurately and with as little injury as possible, to be united in the central palatal line, are advisable because they favor formation of bone. Conversely, methods by which flaps are turned over and the relation of the periosteal and mucous membrane surfaces is altered, while they may be successful in closing the palate fissure, are ill-advised because a membranous yielding tissue covering the region of the hard palate cannot give as good speech results as one more firmly resistant may be expected to produce.

Velum Insufficient through Abnormal Hard Palate Borders, Scars, etc.—On account of ill-formed hard palate at the posterior border, or because of its own insufficiency, the velum palati, after being closed by operation, is sometimes too short, drawn too tightly, or too stiffened by scars to enable it to be made to approach the pharyngeal wall, or meet the base of the tongue with sufficient readiness properly to perform its speech function in governing escape of air through nose and mouth in sound making.

Possibilities of Improvement of These Cases.—A study of the principal difficulties that stand in the way of speech improvement for those who have had cleft palates closed by operation leads naturally to the conclusion that corrective treatment must be along two distinct

lines. The author's experience has shown that almost incalculable assistance may be given such patients by (1) improved operative methods, and (2) better speech training.

The lesson to be read from the unfortunate results of imperfect or ill-advised treatment, as evidenced in results of operation upon this unfortunate class of patients, is not alone that exceedingly great care should be exercised in order that no unnecessary violation of natural processes of development in early infancy or later developmental periods should be allowed, but also that through operative means much may be accomplished by an effort to undo the damage that has been done by reconstruction, readjustment, and improvement of the malformed parts by surgical operation.

Reconstruction of Deformed Lips.—Because of reconstruction of the lip which is ofter too long, or scar contraction upon the inside, the lip has a tendency to curve inward instead of having the natural outward roll. It may also be that the lip is too short or distorted through wrong muscular attachment. These, as well as other lip deformities, can be much improved and the lip made more useful for labial speech office (see Figs. 443 to 463, pp. 613 to 618).

In many instances, through destruction or injury to the premaxilla, there is no development of the dental arch anterior to the cuspid teeth, or, if the incisors be erupted at all, they are in such form as to be of little practical assistance in restoring the contour of the face and giving necessary labial support as well as speech assistance in the utterance of dental sounds.

Correction of Deformity of the Dental Arch.—The dental arch must be restored to its natural form and relation to both the lips and occlusion with the lower jaw. The simplest, most direct, and satisfactory means of accomplishing this is by the insertion of teeth arranged in proper form and attached to teeth in the jaw by means which dentists fully understand and commonly practice.

In the next class of cases the teeth are erupted, in malposition, with the upper dental arches contracted. These arches may be expanded and the teeth placed in proper relation so that the tongue may have sufficient room to give proper speech assistance while both buccal and labial tissues are held in better form. This should only be attempted with exceeding great care and due control of pressure, so that no separation of the line of palate union may occur and unfortunate reopening of the palate be brought about. For this reason methods usually employed in correction of dental irregularities must be avoided or carefully modified.

The results of correction under these conditions have been very gratifying in large numbers of cases. In one case recently, where the velum after closure was less flexible than seemed desirable, through the fact that the patient was thirty years old before the author performed the operation, and though no scar stiffening interfered with movement, the tissue was so scant through want of development

as to give this result. A new operation was performed by making incisions upon each side and carrying tension sutures of wire through from one side to the other without in any way interfering with the central portion of the palate, allowing granulation to fill the division in the tissue thus made, and in that way gaining additional freedom of the soft palate. The speech results in this case are exceedingly good.

Correction of Defects by Operative Assistance.—The question of reoperation in the region of the hard palate, where tissue covering fissure has remained too flexible, is one that requires careful consideration, for fear of doing injury to what has already been accomplished in the closure of the fissure with tissue. Under favorable conditions, however, the mucoperiosteal flaps can be separated from the bone surfaces and carried to the center as for the original palate operation, thus gaining an increase of the surface which best promises cartilage or bony development. This operation the author has usually performed coincidently with an operation demanded for some other purpose, but the results were such as to indicate that there is hope for future improvement of many otherwise comparatively hopeless cases from this method of treatment.

Conclusions from Phonographic Speech Records.—Phonographic records that the author has taken of speech before and after operation in all of the different degrees of palate fissure, as might naturally be expected with a large number of cases, have demonstrated some curious facts. The cases ranged from a slight separation at the posterior border of the velum on through partial and complete clefts of both hard and soft palates varying in width of the separation. Chief in point of interest is the evidence that sometimes an individual with only a bifid uvula, the rest of the palate being intact and apparently normally developed, will speak more imperfectly and with greater exaggeration of the nasal and other defective sounds common to persons with cleft palates than others whose fissures are much more extensive. Some, in fact, with complete fissure through both hard and soft palates are able to speak more clearly than those with almost imperceptibly defective ones.

Many individuals with practically no palate sing quite well, even though unable to speak words with sufficient correctness to be understood.

Case I.—This was that of a girl, aged fourteen years, who had only a fissure in the soft palate before operation. It was impossible to distinguish speech sounds sufficiently for unaccustomed persons to understand what she said. Therefore a phonographic record would have been a mere jargon of unintelligible sounds. She had been unable to get beyond the fourth grade in the public schools because teachers could not understand her. Immediately after operation marked improvement was noted by record. Later records showed remarkable change for the better, and on one or two occasions, after training, she has recited before large audiences, with much clearness and a very good

approximation of perfection of sound, verses in which she had been drilled, but in general conversation her progress was not in proportion to that of better educated patients, as was noted in records of other cases. Eagerness in conversation always tended to cause lapses into old speech habits, and in this case such difficulty was hard to overcome; a difference being apparent if she were allowed to associate for a time with people who themselves spoke incorrectly or carelessly or the reverse.

Case II.—Another girl, aged twenty-two years, with the same character of fissure, but who had a high-school education, could speak much better than the preceding one before operation, the range of her intelligible, even though somewhat nasal, sounds being much less limited. After closure of the cleft, though operative results were quite perfect in both cases, her progress in the line of improvement in conversational sounds was shown by the record to be much more marked.

Case III.—Patient, aged thirty-eight years, was the mother of a grown-up family. The cleft in soft palate was the same as Cases I and II. She was not well educated, but not ignorant and of less nervous temperament than the other two. Speech, as might be expected, was better than Case I and not so good as Case II. Soon after operation, therefore, without training, her record was found to be surprisingly good, due in a considerable measure, no doubt, to freedom from nervousness. Later reports of improvement were much more favorable than was expected.

Case IV.—This patient, a girl, aged sixteen years, in whom the fissure was confined to the velum, as in all the preceding cases, was as uneducated as the first patient, but with less natural intelligence. Scarcely a single word in her first record could be understood. Later and after much training she was able to recite simple rhymes before large audiences quite well, but she has never acquired good speech. Notwithstanding this deficiency, she can repeat after another person, sentence by sentence, even most difficult combinations of words, with little noticeable speech defect.

Case V.—A girl, aged twenty-two years, who had an acquired fissure of the velum, due to hereditary syphilis, was operated on after preparatory administration of potassium iodide, with successful results so far as closing the opening was concerned. It was not perfect in the sense that the preceding cases were, because cicatricial contractions, due to previous ulcerative processes, had stiffened the tissue. Notwithstanding the fact that this deformity was acquired at about the age of fourteen years, and the patient's education was above the average, there was less improvement after operation than in any of the other cases.

Case VI.—In contradistinction to these other cases, a little boy, aged nine years, whose congenital cleft in the velum was like that in Case V, with very imperfect speech, was able to improve so rapidly

that between the months of May and November defects were so overcome that his school-teacher did not notice unusual difference from other children of the same age.

Case VII.—A girl, aged twenty-two years, fairly well educated, with opening in velum palati alone, in whom speech sounds were very bad before operation, was able, by reason of good ear and singing practice, to improve sufficiently to be able to pray and sing alone at Salvation Army meetings within a few months from time of closure. In this case, undoubtedly, religious zeal helped to overcome self-consciousness, together with other mental and nervous hindrances, while constant attendance on the meetings of the Army gave the best possible training to the vocal apparatus.

Case VIII.—A young man, aged eighteen years, had a complete cleft of both hard and soft palates. He is a graduate of a high school. Before operation he was almost impossible to understand, yet in repeating the alphabet unusual ability to pronounce each letter was noted, even the *g*, *k*, and *c* being more than ordinarily good. Stammering was the prime cause of his speech difficulty. The record, taken two days after the last stitches were removed, complete union by first intention having taken place throughout, even to the tip of the uvula, showed an almost astonishing result, since his voice from the graphophone, singing the "Holy City," sounded better, perhaps, than many of our own would if a similar record were taken.

Case IX.—A young man, aged nineteen years, with a fair education, had fissure through both hard and soft palates. The first speech record was better than Case VIII, on account of freedom from nervous habit, but ability to make separate sounds was less perfect. He could sing "Rock of Ages" quite well, and showed great speech improvement in later records as a result of two weeks' singing and drill exercise.

Case X.—A boy, aged nine years, for whom only the preparatory operation had been performed, has given two interesting records. In one he recites the "Lord's Prayer" with an obturator in his mouth, and the next equally well without it, yet with cleft through both hard and soft palates. It must be understood that he could not have learned to speak so well had he not had the mechanical assistance in the beginning.

Case XI.—A girl, aged twenty-two years, highly educated, but with wide cleft through both hard and soft palates, made worse by having had several previous unsuccessful operations, improved so rapidly after the normal form of the palate had been restored by operation that she successfully passed an examination to teach in an eastern law school. The fact that she afterward filled an important position and transacted the telephone business of a large establishment is sufficient proof of her improvement. Undoubtedly her rare intelligence and persistence have been assisting factors.

Hundreds of similar examples of clinical results confirm the correctness of the findings of these phonographic records.

SPEECH DEFECTS DUE TO IMPERFECT DEVELOPMENT WITHOUT CLEFT PALATE.

Speech is an index of individual sex, character, mental capacity, training, state of mind, nervous conditions, general bodily health, and past or present developmental influences.

Etiology.—The causes of defective speech, according to Cohn, are stammering, stuttering, nasal defects or malformations of hard and soft palates, deaf-mutism, and defects of speech due to diseases of the central nervous system.

Ballenger's enumeration of causes is as follows: nasal origin, epipharyngeal and faucial origin, lingual origin, laryngeal origin, thoracic and abdominal origin, deaf-mutism, malformations of palates, and central origin.

From the foregoing classifications the causes of defective speech may be grouped with advantage to the oral surgeon into *nervous, anatomical,* and *mechanical influences.* Radical divisions of this character, which will readily be understood, cannot be arbitrarily insisted upon, because factors belonging to each one of these classes are inseparably dependent upon and associated with those that might be classed in another division. Congenital absence of the sense of hearing or defective brain development or nervous affections common to defectives, insofar as they may prevent or militate against speech, are for the greater part beyond any surgical or medical control. Certainly their control lies outside the field of oral surgery.

A considerable number of nervous affections are, however, susceptible to improvement by the treatment of buccal conditions, as may be noted by reference to the chapter on Nervous Diseases.

All of the methods suggested in this connection should be employed when indicated to assist such individuals toward the establishment of more stable nervous conditions, and to aid speech improvement.

In undertaking the treatment of these cases the most difficult feature often rests upon the decision as to whether the condition is susceptible of improvement or is due to causes that cannot be corrected.

The Correction of Anatomical Defects.—This has already been provided for in the description of the prevention and correction of nasal, palatal, lingual, maxillary, and other oral malformations; with the single exception of the operative treatment of cases having defective speech from imperfectly developed palates that are not cleft, and which upon casual examination give no evidence of the imperfection. These palates have been from time to time referred to in the discussion of other divisions of the subject.

The author's method of treatment is based upon the belief that when there is no nerve lesion or congenital motor insufficiency in the control of the movements of the soft palate, the reason why there is wrong escape of air through the nose, with an imperfect sound such as that which is characteristic of cleft palate cases, is because it is impos-

sible for such patients perfectly to approximate the posterior wall of the pharynx and the soft palate at the proper moment, as is shown in Fig.

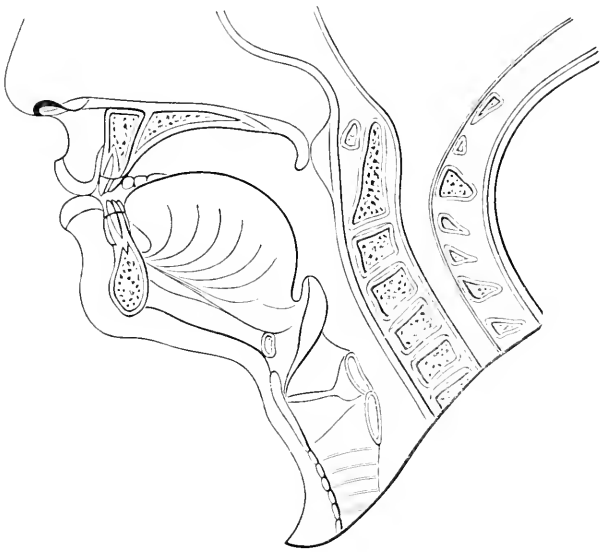


Fig. 503

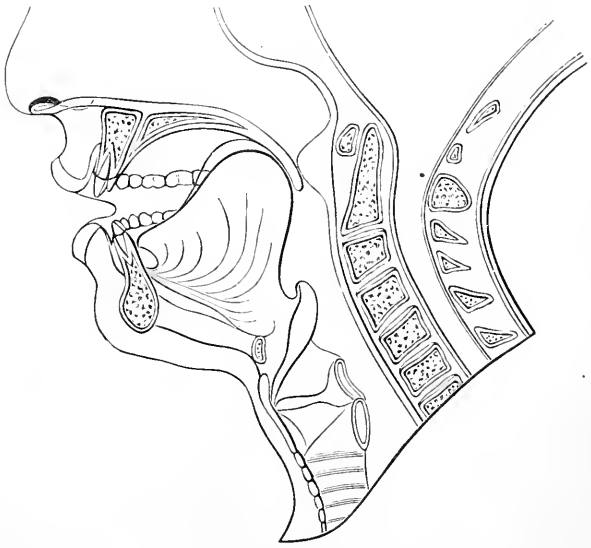


Fig. 504

503, which illustrates the contact of the velum with the projection in the pharynx formed by the pharyngoconstrictor muscles whereby

closure of the nasal openings takes place. This occurs with slight variations in the pronunciation of the elementary vowel sounds and the consonants *p, b, t, d, v, s, z, c, h, j, th, r, sh, l.* Fig. 504 shows the impact of the tongue against the soft palate required in *k, g,* and *ng.*[1] Kingsley's palatograms (Fig. 505) indicate the points of contact of the tongue and palate in articulation of speech sounds.

FIG. 505.—Kingsley's palatograms. Show tongue and palate contact in vocalization of letters indicated.

Obviously, if the hard palate is short, the levator and tensor palati muscles will not have the same leverage as would be the case with a perfect outline at the posterior border of the hard palate. Moreover, the angle at which the velum is suspended will be such as to make it necessary for it to be carried farther upward and backward in order to complete physiological speech function in relation to the pharyngeal wall.

More is therefore required of muscular action that is necessarily deficient. The difficulty is still further increased because the natural effect of this condition upon the palatoglossi muscles is to cause them to be shorter than would be expected if their antagonists of the velum were operating from points of attachment farther back, as would be the case with a normal hard palate.

When the soft palate is unusually short, either because of its own incomplete development or because of the shortness of the hard palate, the difficulties of proper contact with the base of the tongue and also with the pharyngeal wall are increased. For cases in which the uncontrollable conditions previously referred to have been completely and sometimes partially excluded by diagnosis the author has undertaken to remedy the condition of the velum by operation.

[1] American System of Dentistry.

Incisions are made as shown in Figs. 486 and 488 upon each side of the velum in line with the molar teeth. The tissues are separated with the fingers and a retention suture inserted, as shown in Fig. 486 for staphylorrhaphy. This suture is allowed to remain until the healing process has taken place in such a manner as to insure an increase of palate tissue in this region. By this method greater freedom may be given the soft palate in its central portion, and a certain amount of rigidity upon each side, which is believed to be beneficial in assisting function under these conditions.

Division of the palatoglossi muscles, as described for cases of cleft palate and shown in Fig. 485, when the suture is inserted, also gives a measure of freedom in this direction.

In some cases the author has found it necessary to draw together tissues from the ends of the transverse sutures and close them with fine catgut sutures in a vertical line, thus preserving the increased length of these muscles permanently. The operation which naturally suggests itself of causing an increased bone development at the posterior border of the hard palate by raising the mucoperiosteum and carrying it over to a point which will allow the periosteal borders to meet in the center, and retention in this position by sutures, as in closing cleft palate, might be warranted in some cases. Except under unusual circumstances, the danger, however, of creating palatal defects which might result disadvantageously rather than the reverse is too great.

The number of cases operated upon by the author as described has been limited, and the result of speech training which must necessarily be depended upon to supplement the anatomical correction have been undertaken too recently to permit positive statements as to the degree of benefit given.

Sometimes a marked improvement immediately following the operation is noted. At other times the change for the better is less apparent, and the progress of speech training is such that it is impossible to say if progress is more rapid because of the operation than might otherwise be expected. Personally the author has no doubt of the necessity of surgical assistance in such cases the same as with other forms of palatal defects.

Simple Methods of Speech Training Best.—In the matter of speech training, simplicity of method is extremely desirable. Due recognition must be given to all factors incident to individual adaptability and talent, to which attention has been called in earlier descriptions of conclusions drawn by the author from phonographic records of patients, which mark the tendency in this as in any other education to slow or rapid progress.

After an experience of many years, during which there has been unusual opportunity to observe the results of speech training under widely different conditions, the author feels called upon to urge most strongly the avoidance of all methods of instruction that are unnecessarily technical or complicated. They may be alluring from the

theoretical standpoint of a more or less limited observation of certain aspects of this many-sided question, but it is certain that the easier and more naturally the directions given to such persons may be followed, the earlier will improvement be noticed.

As an example of this, two cases, both boys, aged about fourteen years, may be cited. Each had had his palate closed in infancy, both suffered in almost the same degree, from contraction and ill-development of both hard and soft palates, with eruption of the teeth well in toward the central portion of the palate. With both the author used successfully the same method of correction by gradual expansion and reshaping of the palates and dental arches. One of these had had constant instruction from his earliest days not only in English, but also in French, the latter with a view of assisting him in English, as the learning of foreign languages for such patients is one of the accepted forms of favoring speech improvement. The other little patient had had practically no training at all. His parents wisely considered that unless the anatomical defects from which he suffered could be corrected, it were better that he be saved the trials of comparatively useless effort to improve. As might have been expected, the boy who had been taught French and who could not make English sounds correctly was unable to do any better in French. Therefore he had acquired wrong speech habits in two languages instead of one. This is the point that should be borne in mind by others who may feel inclined to undertake this means of improvement. The wonderfully complicated studies of consonant sounds upon which he had apparently spent many hours that could have been more beneficially employed out of doors, gaining health and strength, only tended to confuse his mind and lessen the quickness of response of the many elements of speech mechanism. The difference was markedly apparent because the boy without previous training made much more rapid progress as soon as conditions were favorable, while the other, though quite equal in general intelligence, was found to be exceedingly slow, and effort toward improvement was very difficult.

General Principles.—Better understanding of these differences depends upon due appreciation of the general principles which have been so well explained by Scripture in the following manner:

1. **Reflex Tonus.**—Tonus is a faint muscular contraction due to continuous weak nerve stimulations, easily subject to fatigue, ill health, and other demoralizing conditions, lack of or disarrangement of which causes marked change of voice in both speaking and singing.

2. **Force of Movement.**—This depends on the amount of stimulus sent to muscles, movements of which includes not only those directly involved, but also their antagonists. This requires an excess of effort over what might be expected, but when the innervations are properly coördinated this excess is not necessarily large and fatiguing.

3. **Accuracy of Movement.**—Inaccuracy of movement is a fundamental source of inaccurate and wrong sounds.

4. **Precision of Movement.**—This refers to regularity and evenness of execution and depends on nervous control.

5. **Accuracy and Precision of Coördination.**—This represents the nervous control over simultaneous muscular movements. Some forms of thick speech of alcoholic intoxication and incorrect adjustments during excitement are caused by defective coördination in speech effort.

6. **Quickness of Response.**—This is action of the nervous centers that tends to become automatic. One object in vocal training should be to render speech and song automatic.

7. **Quickness of Muscular Movement.**—This depends on both muscular and nervous quickness, and must be properly balanced; otherwise speech appears labored or slurred.

8. **Auditory Motor Control.**—The learning of speech sounds consists largely in forming connections between motor and auditory sensations.

9. **Ideomotor Control.**—Sounds occurring simultaneously with sights, touches, tastes, smells, emotion, act of will, etc., tend to be connected with them, so that when any one of a complex group occurs again, the others are revived more or less clearly in consciousness. It is in this way that speech movements become associated with printed letters.

10. **General Voluntary Control.**—This is subject to changes of nutrition, fatigue, emotion, and general habits, on all of which vocal control must place its dependence.

The author is indebted to Prof. Carberry, of the Wisconsin Conservatory of Music, for the following suggestion, which has proved to be exceedingly useful in the management of postoperative speech-training cases. As vocal instructor, he is accustomed to teach that the Italian *a* is the basal tone, modification of which, with but slight alteration of physiological action, allows sufficient change to utter clearly each of the other vowels, and even the consonants. With the organs in position to make this tone at the beginning of the sound, all parts are under the least possible strain. The resultant sound effect therefore will be most natural, and for this reason can be carried on up through the various registers of the voice to higher notes without sacrificing purity as must necessarily be the case if there is the least strain upon the voice or the sound-producing mechanism connected therewith at the moment of inception.

Applications of this principle to speech training show that the confusing and complicated systems which involve special direction of the attention to lips and tongue for each particular letter of the alphabet are not only largely unnecessary, but in some instances, at least, most unadvisable. For with overanxiety causing undue nervousness and tendency to unconscious contraction of all muscles, and the added difficulties of other speech defects induced by nervous conditions, that so commonly affect these patients as to make additional complication, there can be no question that the simpler form of training and the more devoid of multiplied rules of procedure such instructive methods may be, the more easily and rapidly speech improvement will take place.

The easiest and the most natural way to overcome these unfortunate speech habits seems to be the use of the voice in singing.

Conclusions.—No individual with cleft palate, no matter how bad the condition, need be utterly discouraged.

In every case (age being no contra-indication) operation for closure of palate fissure should be performed.

No unnecessarily forcible methods should be employed in early infancy. Defects of lip, nose, and palate due to imperfect operative results, which are frequent causes of slow speech progress, may be much benefited by corrective operation.

Avoid complicated methods of speech training.

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CHAPTER XIV.

THE TREATMENT OF WOUNDS UNDER WAR CONDITIONS.

The experiences of the war in Europe, with wholesale destruction of tissue by an infinite variety of projectiles and the ever-present dangers from battlefields planted with pyogenic microörganisms through centuries of fertilization with manure, the diseases of the trenches, the inhalation of poisonous gases, the burns of flames sent broadcast among the soldiery, frost-bite, the diseases of exposure and unsanitary conditions, have so changed the order of routine treatment of wounds that had previously been found to be satisfactory under ordinary conditions that a work of this character would be incomplete without at least a brief reference thereto.

Tetanus.—The horrors of tetanus, whenever the antitetanic serum could be procured, have been largely prevented by the early injection of the serum in all cases of serious wounds.

Infection by Gas-producing Organisms.[1]—According to Mackenzie Forbes, "these are of the anaërobic variety. The bacillus of malignant edema is the most common. More rarely found is the Bacillus aërogenes capsulatus (Welch). Infections by these organisms are characterized by their virulency. It is necessary to recognize them early, because at first the infection is local, although usually of a deep wound, and practically always of the lower extremity.

"A wound so infected is dirty in appearance. It contains pus, or pseudopus, with a fecal-like odor, which is similar to liquid feces in color and consistency. The parts about it are swollen and congested, but at this stage no characteristic crackling can be elicited by palpating the surrounding tissues; thus it may be difficult to differentiate it from an infection by the colon bacillus. Later there may be localized gangrene around the wound, about which crackling can be elicited on careful palpation. In some cases this latter may be noticed without a suggestion of gangrene. The condition at first is really one of cellulitis. The patient's general condition, which is due to toxemia, is often far worse than is suggested by the local lesion. In those cases in which crackling is found on palpation there can be no doubt as to either diagnosis or treatment. In the earliest stages, in which there is doubt as to the diagnosis, open freely and drain. When crackling is found, treat at once as for a fulminating cellulitis, where the freest incisions and drainage are indicated. At the same time hydrogen dioxide may be injected into the surrounding subcutaneous tissues in an attempt to limit the infection. The infected area must be kept under constant surveillance, always remembering that to save life, amputation in the case

[1] Notes on War Surgery, British Med. Jour., p. 369.

of a limb may be necessitated at any time. When gangrene has appeared, amputation is necessary. This may be done through the emphysematous tissues if the open methods to be described later are employed.

"In dealing with infections by gas-forming organisms it is necessary to keep in mind that the patient's life is endangered from the very beginning, and although early and very free incisions may relieve the patient even in cases in which we are dealing with a cellulitis alone, amputation with free drainage may often have to be resorted to in the end in order to save the patient's life."

Morriss[1] calls attention to the fact that "modern trench warfare created an unexpected situation, and at present the military surgeon faces problems which in some respects are novel. A majority of the wounds are caused by pieces of shell and shrapnel balls, and generally these are infected. Even rifle wounds are rarely aseptic, for the range is short and the explosive violence correspondingly increased. Shattering of the bone and hernia of muscle are common. These conditions, resembling those in wounds caused by low-velocity projectiles, nearly always lead to suppuration. Accordingly all wounds are treated from the first as if infected, and antiseptics are used with Listerian rigor."

Bull has recently elaborated a gas-gangrene bacillus antitoxin, by the injection of which he claims both growth and toxic absorption are inhibited.[2]

Antiseptics.—Since practically all wounds are infected and great enlargement usually is necessary because clothing, foreign bodies of various kinds and other infective agents are driven into the tissues by projectiles, and especially because the frightful sloughing and edematous conditions of the tissue require extensive incisions for relief and drainage, as well as large exposed areas in which portions of the body have been torn away, the problem of combating infections by the use of antiseptics is a very serious one. A natural result of this has been the trying out in the various base and other hospitals of practically all known antiseptic agents. The net result of this has been the general adoption of the use of Dakin's fluid.

Dakin's solution[3] is an aqueous solution of 0.5 per cent. concentration of sodium hypochlorite, and is made as follows: Dissolve in a large bottle 140 grams of dry carbonate of soda with 10 liters of sterile water. Add to this 200 grams of chloride of lime (bleaching powder) and shake well. After half an hour siphon off the clear fluid into another bottle through cotton or filter paper and then add 40 grams of boric acid to the clear filtrate. This solution is neutral to litmus, is non-irritating and is the proper strength for wet dressings and irrigations. A stronger stock solution of 4 per cent. may be made, but the quantity of boric acid to be added must be determined exactly, so that the solution is just acid to phenolphthalein suspended in water; otherwise the solution decomposes very quickly. The solution should be made fresh every three or

[1] The Military Surgeon, xxxviii, 131.
[2] Report of Demonstration before the National Council of Defense.
[3] Harnbogen: Journal of Michigan State Medical Society, September, 1917.

four days, and the dry stock ingredients should be kept in covered receptacles. Besides its proved efficiency, another point worthy of consideration is that this solution can be made up, even in small amounts, at a cost of only about five cents for 10 liters.

The advantages claimed for sodium hypochlorite solution in the treatment of septic wounds are: (1) The simplicity and cheapness of preparation of the antiseptic. (2) It is non-toxic and non irritating to the tissues when properly prepared according to Dakin's formula; the hypochlorite solution may be safely used in large quantities over long periods of time without ill effects. (3) The deodorant action of the solution is remarkable; the fetor from gangrenous tissue usually disappears in twenty-four hours. (4) The rapidity with which sloughs separate and clean granulation tissue is forced in a wound under its influence. (5) The infrequency of redressing required by cases treated with hypochlorite compared with the constant change of dressing required in large wounds with other forms of antiseptics. (6) The fact that injections of the hypochlorite solution into rubber tubes used in the dressings may with safety be entrusted to very imperfectly trained orderlies without fear of ill results, once the case has been adequately dealt with by the surgeon.

Dichloramine-T, Dakin's latest antiseptic solution, twenty times as powerful as the watery solution used in the Carrel method, is dissolved in oil of eucalyptus and applied by a spray.[1]

The therapeutic value of this agent is now universally recognized.

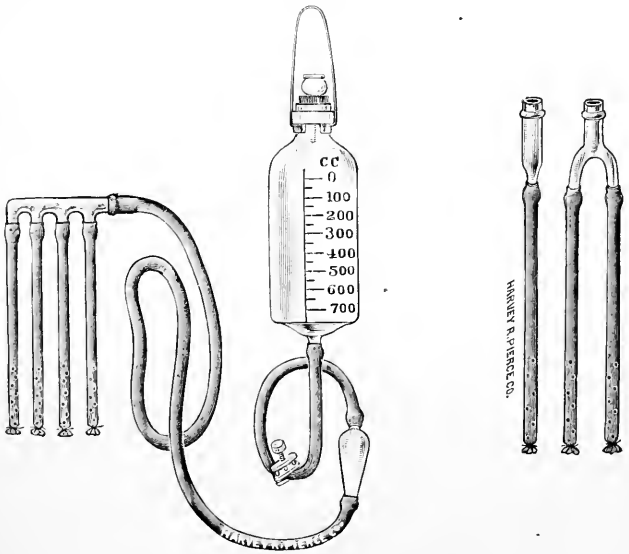

FIG. 506.—Carrel's apparatus for administering Dakin's solution.

Carrel's Method (Figs. 506, 507 and 508).—The Carrel tube is made by placing a perforated rubber tube one-quarter of an inch in diameter

[1] Le Conte: Report of the National Counsel of Defense.

in cloth of coarse material, as rough toweling. One thickness is placed around the tube and sewed. These tubes in different lengths are placed in the tract made by the missile, through the wound of entrance and through the wound of exit, lying alongside of each other in the tract. The solution is then injected every two, three or four hours, or can be used continuously. Dr. Carrel advises that in the wound there should

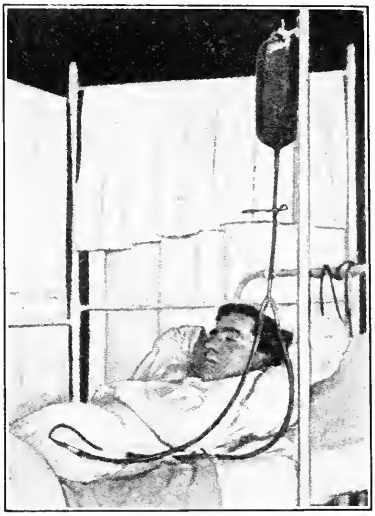

FIG. 507.—Carrel instillation apparatus. The receptacle is blackened to prevent decomposition of the hypochlorite solution by sunlight.

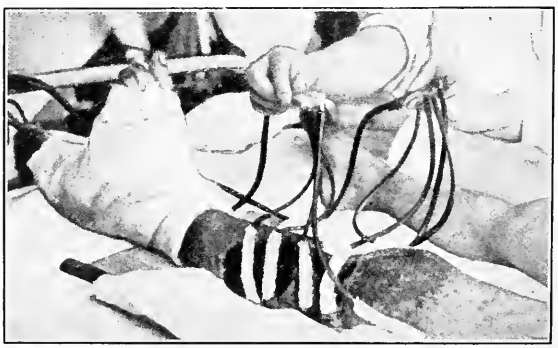

FIG. 508.—Carrel's method as applied in treatment of leg wound.

not be any effort made on the part of the surgeon to clean out the foreign particles of dirt; in fact, no disturbance of the wound in any way, but it has been our custom to clean out all blood clots. This solution seemed to give the best results in cases that had received their injury only a few hours previously. The tubes were generally left in the wound from twelve to fourteen days, and upon removal the wounds seemed to heal very rapidly. The exudate was never as abundant as in

the other cases and did not have the appearance of pus but that of a thin colorless jelly-like substance.

Hypertonic and Isotonic Salt Solutions.—The attempts on the part of the surgeon to increase the combative forces of the body are at times very discouraging, and there are several things that have to be taken into consideration. The one word *stimulation* will cover a great deal of it; first, the stimulation of the physiological forces; second, that of the protective elements, and, third, that of the action of the white blood corpuscles (phagocytosis). It may be said that the action of salt solutions has been known for many years, but the use of solutions of different strengths for different bacteria is comparatively new. For instance, the hypertonic solutions have a very pronounced effect upon the pyocyaneus and greatly stimulate the action of the white blood corpuscles. The isotonic act best in the streptococcus infection and also show a tendency to dilute the lymph, and in this way make it possible for the white blood corpuscles to enter the wound and carry on their work. It is known that they are the most deadly enemy of the streptococcus, while this organism does very well in lymph.

THE IMMEDIATE TREATMENT OF WAR INJURIES.

An eminent United States army medical officer, after experience in both English and French hospitals, gives the following conclusions:

"The first and most important factor is time: the patients must be seen early, preferably in six to eight hours, and certainly within twenty-four. When they cannot have adequate treatment inside two or three days the amount of gas infection and the severity of it is appalling. Cases that would have meant simply a thorough debridement, as the French, or excision, as the British call it, in the early treatment require perhaps high amputation or may die, no matter what the treatment, in a few hours. A fulminating type of case may not last twenty-four hours. In the very early stages of gas infection one sometimes finds only one or a small group of muscles involved—excise these and the patients get well. The signs are restlessness; pain that is very characteristic—due to the swelling; rapid jump in pulse, say 120 to 140; great swelling; tenderness may or may not have crepitation; thin grayish discharge, with very characteristic sweetish odor. On opening the wound the muscle is grayish, non-contractile when pinched with forceps, and there is a very little grayish discharge. Infection tends to run up the muscle. Excision of the infected muscles or amputation, the stump being packed open with magnesium sulphate or flavine, is the treatment. Roughly, there are three clinical types, the more superficial type being not so rapid, with bronzing of the skin and crepitation. This type is treated by extensive multiple incisions and is relatively rare. Second, there is the massive gangrene from swelling and occlusion of the circulation at an early stage.

This requires amputation. Then there is the most common type, with infection of the different muscles, with some shutting off of the circulation from swelling and the extension of the muscle involvement, determining the treatment, whether they can be excised or if both the more superficial as well as deep muscles involved. Amputation is necessary for these cases. There is a serum that has yielded good results experimentally, but in the few cases in which I have seen it tried I cannot say definitely that it has been of value. It is for the B. welshii type, I believe. All these cases can practically be prevented if the patients are treated early enough by excision. If there is a wound of entrance and of exit they are not *x*-rayed but penetrating wounds, are screened and the location and depth mark placed by the radiographer before they come to the operating room. It is a good plan always to find out in what position the patient was when he was shot, as it helps to locate the foreign body and to follow down the tract. In the operating room the patients are shaved, washed and painted with 2 per cent. picric acid in methylated spirits, the wound is excised, the tract is widely laid open and all injured muscle, bits of free bone, foreign bodies, and areas of hemorrhage removed with scissors and forceps or with the knife. Nerves and sometimes tendons are sutured, but so far as possible, catgut, etc., are avoided, so as not to introduce foreign material into the wound. All joints are treated in this manner and invariably sewed up tight. Sometimes 'Bip.' (bismuth, iodoform, paraffin) is introduced before closure. In other cases than joints primary suture is only done when the patient can be kept for five to ten days, as transport has been found very detrimental to good results, probably from traumatism and the exudate that is caused. Usually the wound is packed wide open with flavin. This can be left in for from two to four days, is non-irritating and leaves a healthy field suitable for delayed primary suture, this being done at the base in three to six days, the patient being evacuated as soon as possible after the primary operation. If flavine is used as a dressing for more than five days granulations become sluggish. Results in treatment of compound fractures by primary suture are good, but the patient cannot be moved. Only remove free bone fragments; all that are attached by periosteum should be allowed to remain. The commonest failures are due to a hemolytic streptococcus. In these cases there is a thin grayish discharge and the edges of the wound appear to melt away. One thing is pretty definite in regard to war wounds: the whole secret is cleaning the wounds mechanically by excision of the wound and traumatized tissue, thus removing the infection before it has a chance to spread. Time is the factor. The French are keen on the use of ether in wounds and the British 'Bip.' or flavine, but neither will keep a wound from becoming infected if it is not freely opened up, cleaned out and foreign bodies removed."

The record of wounds in the base hospital work in Russia, reported

by Major H. H. Snively,[1] N. G. Ohio, late director-in-chief of the American Red Cross in Russia, shows a proportion of fractures of the jaws to other fractures:

RELATIVE FREQUENCY OF JAW FRACTURES IN WAR WOUNDS.

	Grand total.
Cranium	78
Face	114
Mandible	205
Hyoid	6
Vertebra	19
Ribs	78
Pelvis	28
Clavicle	60
Scapula	68
Humerus	235
Ulna	176
Radius	153
Carpals	64
Metacarpals	77
Phalanges	160
Femur	163
Patella	26
Tibia	123
Fibula	70
Tarsals	38
Metatarsals	26
Phalanges	31
Total	1998

THE PRINCIPLES OF PLASTIC AND ORAL SURGERY AS APPLIED TO WAR INJURIES.

The essential features to be considered in the treatment of extensive war wounds of the face and jaws are:

1. Antiseptic precautions to provide the utmost preparation for healing which will facilitate in the highest possible degree future reconstruction, with a view to the restoration of both functional and cosmetic effects.

2. The correction of fractured and displaced bone structures. For this purpose any of the splints and appliances shown in Figs. 172, 174 to 189, 218 to 224, 235 and 236, illustrating the treatment of fractured and resected jaws, might be applied. In addition to these it is interesting to note the infinite number of ingenious appliances that have been successfully used in the hospitals of France, England, Germany and Austria during this war, as presented in the illustrations of this chapter.

3. The use of artificial supports to hold the soft parts in such position when plastic operations are performed that the healing may be of such character as to give the best possible form. For this purpose various substances have been used. Most commonly, however, vulcanite,

[1] The Military Surgeon, xxxviii, 634.

as shown in Fig. 554, tin as illustrated in Fig. 556, and modelling compound, as demonstrated by Dr. Joseph C. Beek, of Chicago, Ill., and illustrated in Figs. 509 to 524. The author has found gutta-percha

FIG. 509.—Incision for resection of the upper jaw. From outer canthus to side of nose, down and under nose to median line through hard and soft palate.

FIG. 510.—Temporary resection of the upper jaw. Chisel through zygoma, intra-orbital margin, nasal process of superior maxilla and aperture. Between central incisors through hard palate everting mass.

FIG. 511.—Permanent resection of the upper jaw. Remove everted fragment of maxilla as well as any overhanging portions, also posterior lateral part.

FIG. 512.—Cavity filled with gauze, retained in a sort of hammock fashion.

very useful for this purpose, in a considerable variety of cases, because of the facility with which it may be molded to the form of the parts and its complete freedom from irritating tendencies.

4. Bone-grafting, which must be resorted to when considerable portions of bone have been lost beyond the point from which it might be expected restoration could occur by natural growth without grafting if the parts were held in position. That natural restoration is pos-

FIG. 513.—Cavity filled with dental modelling compound.

FIG. 514.—Shape and size of filling mass. Temporary support made of dental compound to aid normal healing of face.

FIG. 515.—Wound closed.

FIG. 516.—Shows compound comminuted fracture of mental region of lower jaw, including loose teeth.

sible to a much greater extent than is commonly recognized is shown in Fig. 259, page 440, Fig. 291, page 467, and Fig. 526, page 678. In each of these cases the author removed almost all of the mandible from near the angle of the jaw on one side to the bicuspid region on the other, and by preserving the periosteum and the natural outline of

the jaw sufficient hard structure was reproduced to retain the correct outlines of their faces. The young woman now wears a vulcanite plate in the lower jaw, with complete comfort over the region from which the bone was removed. In the author's opinion many jaws have been

FIG. 517.—Shows fragments adapted and useless particles of bone removed.

FIG. 518.—Shows fragments wired.

bone grafted, which if simply held in proper position, with perfect fixation, would have received sufficient restoration without such treatment. A further example of this is shown in the case of the young woman shown in Figs. 525 and 526, in which after having false union

FIG. 519.—Shows defect with fragments removed.

FIG. 520.—Shows all fragments removed and cavity filled with dental compound.

in the mental region of the lower jaw for twenty years, upon fixation in the course of a few weeks the parts became quite firm.

5. The transplantation flaps of tissue from other parts to supply covering for wounds with extensive loss of tissue.

6. Orofacial prosthesis, or the restoration of lost portions of the face by artificial substitutes made from metal, vulcanite, wax or other suitable substances.

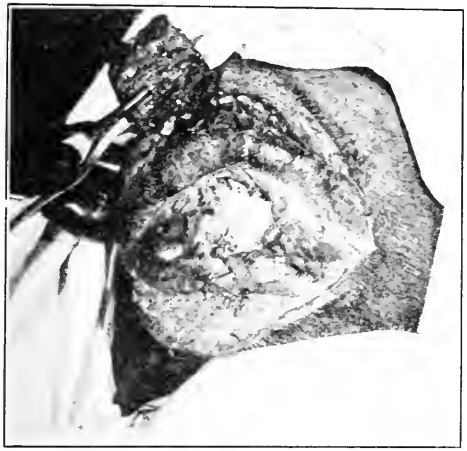

FIG. 521.—Shows the dental compound model for subsequent prosthesis.

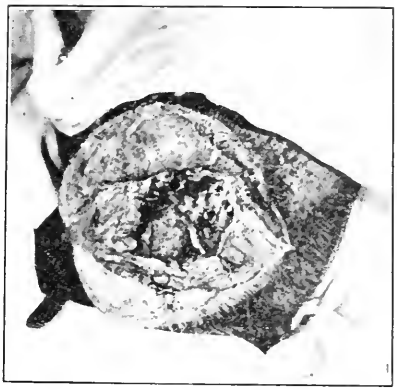

FIG. 522.—Defect filled with clavicle transplant and wired.

The principles of bone-grafting are now well understood, the use of metal plates such as those devised by Sir Arbuthnot Lane, of London, and the Sherman plates shown in Fig. 552 and modifications of these fixation devices have been quite general among surgeons with varying degrees of success.

FIG. 523.—Shows teeth wired and held in apposition with the upper jaw.

FIG. 524.—Shows wound sutured and drainage tubes at the lowest part.

There are, however, certain special features of this work that relate particularly to jaw conditions which must be provided for under every

condition, when the continuity of either jaw is lost by injury, whether the cause be accident, surgical or gunshot.

The immobilization of a divided mandible is sometimes not so easily accomplished as illustrations would often make it appear, and without it a mandibular bone graft has small chance of accomplishing the desired result.

FIG. 525.—Congenital fibrous band extending from the jaw to the clavicle, causing deformity shown and rendering it impossible to hold the head comfortably in an upright position. The divided jaw was fixed with a splint attached to the teeth.

FIG. 526 (same girl shown in Fig. 525). —After correction of the defect by a transverse incision at a point just above the thyroid cartilage through the fibrous band and after freeing the surrounding tissue the skin was drawn from the central portion of the incision above and below, upward and downward until when brought together the line of incision was perpendicular instead of parallel. A slight trimming of the skin at each end of the suture line was necessary in order to complete the outline of the neck.

Infection from the oral secretions, if by chance the wound for insertion of the graft penetrates the buccal mucous membrane, is also a serious disadvantage.

Albee, whose methods of cutting, insertion and fixation are illustrated in Figs. 531 and 533, had devised methods to meet these diffi-

culties, and through his wide experience has full realization of the importance of such considerations.

In the *reconstruction* of faces deformed by the more extensive gunshot and other war injuries, the underlying conditions and effects are precisely the same as those encountered in the correction of the lesser defects illustrated in Figs. 373 to 410 and Figs. 433 to 467, in which congenital deformities of the lip and nose and the exaggeration of these by previous operative treatment required reconstructive surgical operations for cosmetic purposes. It is therefore important to remember that whenever it is possible to take advantage of the elasticity of the tissues of the face and neck to extend them so as to cover or at least partially cover a surface from which the tissue may have been lost, this should be done. If necessary, step operations may be continued until the closure is completed without transposition of tissue from another part. The result in the course of time would then be much more perfect both from the functional and cosmetic considerations. If, however, the defect is so extensive that this is not possible then the transposition of a flap from some adjacent part or from the arm according to well-known methods may be necessary. A mass of tissue without the possibility of muscular adaptation to give proper functional activity may be helpful in improving the appearance of the individual, but in the last analysis must nearly always be more or less disappointing. It is a grave question if in many cases where plastic surgery is attempted a prosthetic appliance artistically made and adapted might not give a better appearance than the surgical result.

AMERICAN AMBULANCE HOSPITAL METHODS OF TREATMENT OF JAW FRACTURES.

Dr. Harvey Cushing,[1] M.D., Medical Reserve Corps, U. S. A. (Inactive), surgeon-in-chief to the Peter Bent Brigham Hospital, Boston, Mass., pays this tribute to the American Ambulance of Paris: "A practical example of the value of surgical specialization in warfare is afforded by the experience of the American Ambulance in Paris, where, owing to the brilliant reparative work on patients with fractured jaws, inaugurated by Dr. Hayes and his colleagues, of all inmates some 20 per cent. were victims of wounds of this type. A general surgeon can set a broken jaw, but as a rule just badly enough so that the teeth are not in exact alignment, and a soldier who cannot masticate coarse food is about as ineffective as one who has crippled feet. If Napoleon's army marched on its belly, Joffre's holds on with its teeth, and only experts can make 50 per cent. of lacerated faces and jaws capable again of army crusts."

Dr. Benjamin Jablons,[2] pathologist of the American Ambulance

[1] The Military Surgeon, xxxviii, 605.
[2] New York Med. Jour., civ, 552.

of Paris, gives the following summary: The cases treated may be divided into two general classes. First, gunshot injuries; a large majority of which have involved compound and multiple fractures, and, second, gunshot wounds of the face involving the maxillæ, and requiring the intervention of dental surgery. This latter class has greatly increased in number, owing to the unique facilities of the American Ambulance for their treatment. The number of patients received during the year ending August 31 has been 2622, of whom 1968 have been discharged, cured, or improved; 117 have died and 536 remained under treatment. The death-rate has been 4.46 per cent. Dr. Francis Wilson, of Paris, formerly Chief of the Dental Service of the American Ambulance Hospital (B. at Juilly), Paris, with his associates Drs. Hayes and W. Davenport (at Neuilly) and others, during three years of faithful service, took personal charge of an enormous number of cases of fracture of the jaws. The restoration work accomplished by these men and other Americans scattered throughout the hospitals of Europe will long continue to be a matter of national as well as professional pride. Dr. Wilson writes: "As Juilly was more a front line, we were often obliged to evacuate our wounded before they were cured. For example, in September, 1915, I had 52 cases of fracture of the maxillæ enter the hospital in one afternoon; of these I saw only 2 completely cured—all the others were sent to hospitals away from the war zone some ten days later. Among these 52 cases were some of the worst that have ever come under my observation. In fact, it would be difficult to imagine how many of these could have been worse. One poor fellow had the entire face below the eyes blown off, nothing remaining of the inferior maxilla. Among the simpler cases a great many multiple fractures, particularly of the lower jaw, some fractured in five, six, seven, or eight places. My work was to wire these together so the man could eat soft food besides being more comfortable. The mouths were washed out with a mild antiseptic or normal salt solution as many as six or eight times a day. When the inflammation subsided sufficiently, we took impressions, extracted useless roots and made cast splints which were cemented to place. I might mention that very often portions of the inferior maxilla would be found missing ranging in size from slight splits to even half or all of the jaw. We find with a good interdental splint that nature furnishes bone substance in many of the cases.

A case in mind brought in February, 1916, was wounded in the lower maxilla in the region of the right canine by a splinter of shell. The lower right lateral and central incisors were carried away together with a portion of maxilla the same width as the combined width of the teeth above mentioned. I put on a splint allowing for the space between cuspid and left central and from three weeks to a month after he had an osseous union of the two portions.

Examples of the conditions under which first-aid treatment must be

rendered in war injuries of the jaws upon the success of which later reconstructive operations must depend are shown in Figs. 527 to 530.

FIG. 527

FIG. 528

FIGS. 527 and 528.—Loss of the entire right side at the superior maxilla destroyed by a piece of shell.

These cases were selected from among those treated by Dr. Francis Wilson, of Paris, in Neuilly, at the front line hospital in Juilly. (Photographs by Mr. Frank Burky.)

FIG. 529.—Shell wound with loss of the entire mandible anterior to the ramus.

FIG. 530.—Illustrates a case in which hemorrhage occurred three weeks after the patient entered the hospital, requiring the ligation of the right external carotid artery, and eighteen days later when the same operation was required on the left external carotid because of the anastomosis from the left to the right side. (Photographs by Burky.)

The wonderful work accomplished by the Association of Surgeons and Dentists in the treatment of these cases in Neuilly is illustrated in Figs. 546 to 553.

OPERATION IN INFECTED FRACTURES.

Joseph Rilus Eastman, M.D., F.A.C.S., Indianapolis, Indiana, formerly chief surgeon, Reserve Hospital No. 8, Vienna, Austria, has written especially for this chapter these conclusions from his war experiences:

It need hardly be said that infected gunshot fractures do not tolerate open operative interference. Practically all gunshot fractures are infected, therefore the field of operative surgery in war fractures is relatively small.

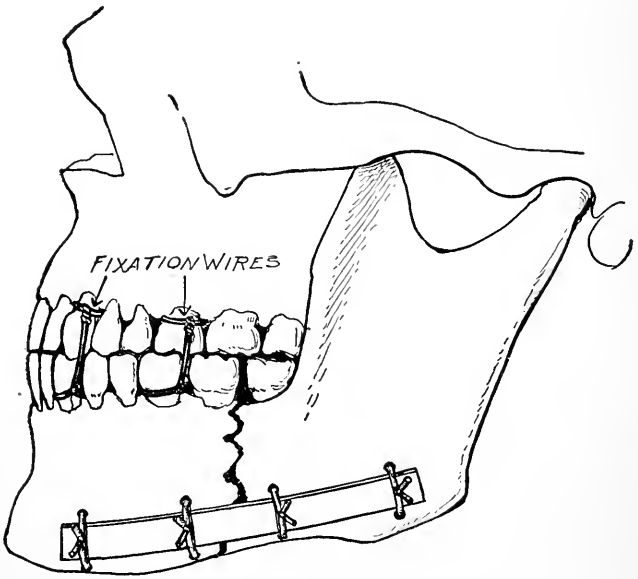

FIG. 531.—Diagram of a fractured lower jaw illustrating the inlay bone graft in place imbedded in the gutter cut in both fragments by the twin motor saws. The graft has been procured from the antero-internal surface of the tibia cut by the twin motor saws adjusted at the same distance apart as when cutting the gutter in the jaw fragments. Note the drill holes and that the graft is fixed in place by kangaroo sutures. (Albee.)

In the case of gunshot fracture of the lower jaw, the experience of this war has proved that primary bone suture or wiring is to no good purpose. It has been shown in these cases that primary bone suture is rarely effective, that primary healing never occurs, and that suppuration and sequestrum formation always follow. In other words, the primary bone suture in jaw fractures does only harm and no good.

The experience of the present war has demonstrated that for weeks after apparently complete healing of gunshot fracture wounds, the infection lurks in bone and soft tissues about the site of fracture, making any open operative procedure a dangerous undertaking.

Fractures plated two months after the disappearance of every discoverable vestige of infection or inflammation have reacted with what bore every evidence of a recrudescence of the old infection. The x-rays in these cases revealed no signs of inflammation and none were found during the operation itself.

A gunshot fracture healed, but harboring a dormant infection, could hardly be subjected justly to operation, especially a plastic operation, except upon the erroneous assumption that the infection had entirely disappeared. As it is almost impossible to learn before or even during operation of the presence of infection in healed cases and in so much as the infection often persists for months with no manifestations whatever, it follows that open operation in healed gunshot fractures should not be undertaken without due sense of the dangers of lurking infection. The manipulation required to complete a bone plastic operation without much doubt stirred up latent

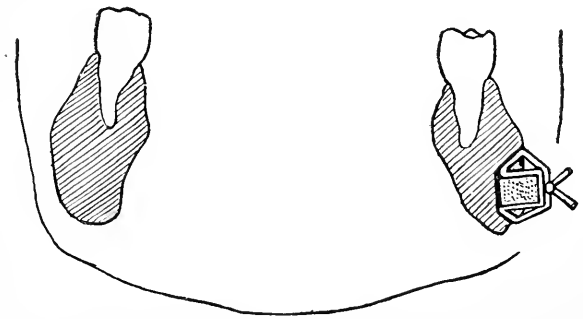

FIG. 532.—Diagram showing a cross-section of the inlay bone graft implanted for a fracture of the lower jaw and showing the method of securing the graft in position by the kangaroo-tendon suture passed through the drill holes and over the graft, holding it securely in position. (Albee.)

infections in several of our cases. Fortunately, frequent continuous irrigation with Dakin's solution permitted good approximation of the fragments and sufficed to control the infection, which was from the beginning of its flare-up in an attenuated form, the discharge being made up largely of lymph and containing relatively few pyogenic bacteria and pus cells. Such experiences teach a lesson which although in a sense generally understood, is perhaps not sufficiently appreciated, *i. e.*, that open operation in gunshot fracture with deformity is not indicated before two months at the very least have elapsed after the disappearance of every sign of infection. Then the operation should take the simplest form possible under the circumstances, which means simple osteotomy with splinting in a large percentage of cases.

In completely healed infection-free gunshot fractures, the autogenous bone graft represents the ideal method of holding fragments in alignment and coaptation. If an autogenous graft cannot be obtained the bones of a dog or those of a calf may of course be utilized,

but far greater safety and greater convenience consist in using bone pencils cut from the edge of the tibia or from some other bone easily accessible. Judging from a limited experience in the use of autogenous grafts for the retention of fragments in good position it has appeared that such grafts cause less irritation and have less tendency to provoke recurrence of infection than do plates or other metal devices.

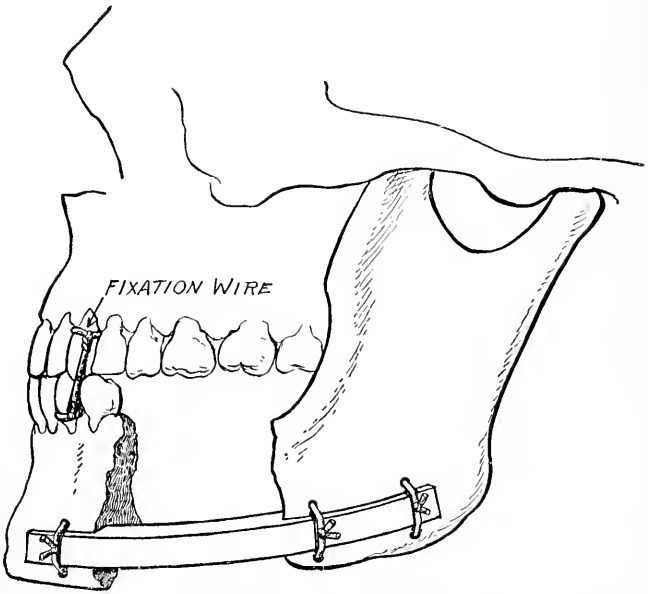

Fig. 533.—Diagram of a fractured lower jaw so badly shattered as to leave a gap where a proper position of the remaining fragments is maintained. This gap can be satisfactorily spanned and the fragments securely united through the inlay method with a graft and gutter produced by the twin motor saws adjusted at the same distance apart, producing an accurate fit of the graft which is held in position by kangaroo-tendon sutures passed through drill holes in jaw fragments. This is a frequent condition in the present war, resulting from the trench warfare. (Albee.)

Whether the transplanted bone heals in as a foreign body and later disappears by resorption, as held by Ollier, Gebhardt, and Ullmann, or whether a part continues to live as stated by Marchand and Axhausen, is an old question of no great importance in this connection. The important clinical fact for us is that if laid in correctly the graft unites in some manner with the surrounding bone and serves as a support. As advised by Shaffer no more bone should be transplanted than is absolutely necessary, and care of course should be taken that the osteoblastic periosteum is intact along one side or margin of the peg or intramedullary graft. Moreover, the grafts should be so cut as to contain as little compact bone as possible for the generally admitted reason that compact bone after transplantation requires a longer time for resorption than does spongy bone, the porosity of which allows the ingrowth of vascular connective

tissue and lime-bearing osseous trabeculæ. Care should also be taken that no blood or devitalized tissue is interposed between the intramedullary pencil and the endostium of the fragments, since the resorption of such foreign matter must of course precede the ingrowth of vascular connective tissue into the graft.

It is probable that in our cases the intramedullary pencil serves merely as a support. The dowel graft, however, if inlaid so that the periosteum of the graft lies in contact with the periosteum of the fracture fragment and with the other bone layers in normal relation actually grows into the surrounding bone. In the case of the intramedullary pencil it is practically impossible to bring the periosteum of the graft into contact with that of the fracture fragment. How-

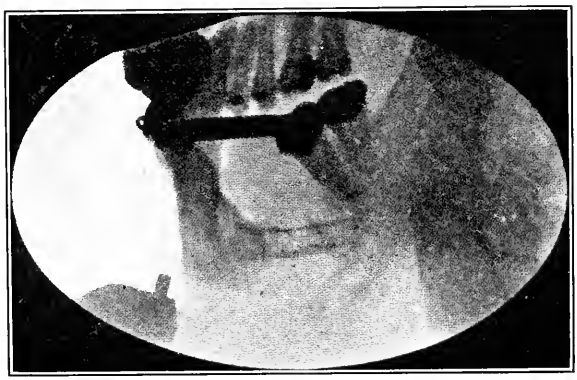

Fig. 534.—Illustrates bone graft in place with fixation of the jaw fragments by a cap splint cemented to the teeth as described by Mr. Montagu Hopson, L.D.S., R.C.S., dental surgeon to Guy's Hospital; consulting dental surgeon to the War Hospitals in the London Command in the War Supplement of the British Dental Journal. In this case a segment of the sixth rib was made to fit in the notches cut in each exposed end of the fractured mandible. This splint has since been removed and an artificial denture inserted with complete success.

ever, as above stated, the matter of chief importance is that the autogenous intramedullary splint provides good support during the process of union of the fragments, and this it seems to do much better than a dowel graft insofar as our cases were able to illustrate. Though the dowel graft with proper apposition of histological layers grows in, and the intramedullary autogenous bone splint remains in most instances as a foreign body, nevertheless, in fractures with obstinate tendency to angulation, the bone peg in the medulla gives the best possible support, the thing most desired.

In view of the danger of arousing latent infections in healed gunshot fractures with shortening, Finisterer, of Vienna, has advised that all open operations made during the first year after healing of the wound should be made at the site of the fracture but remote from it.

In treating infected wounds the following resources are employed in the American Hospital in Vienna:

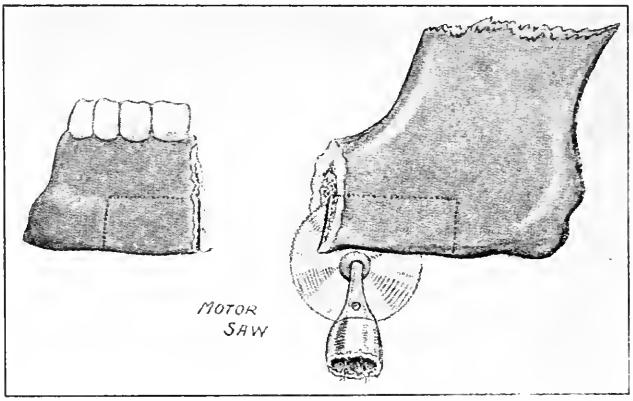

FIG. 535.—Application of the motor-saw in operation for closing gap in mandible produced by gunshot wound. (After Gallie and Robertson.[1])

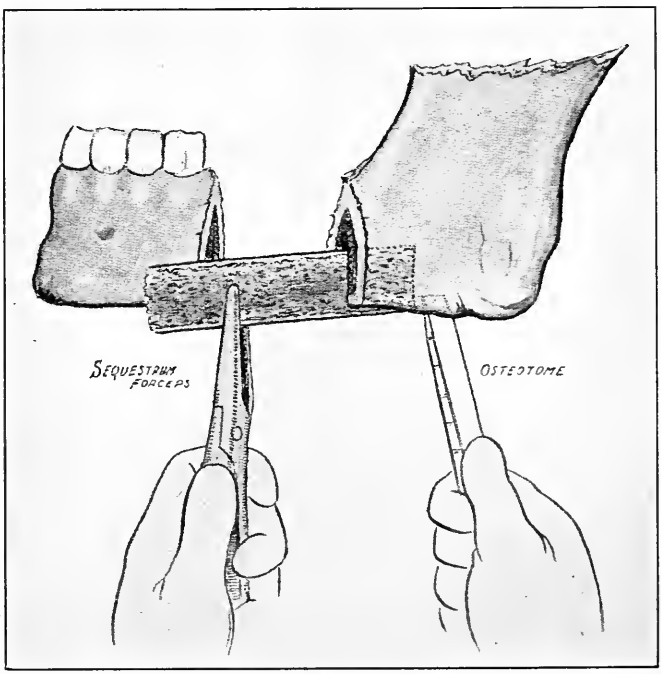

FIG. 536.—Insertion of half of split rim with smooth side toward the mouth cavity. (After Gallie and Robertson.)

[1] Transplantation of Bone. By W. E. Gallie, M.D., and D. E. Robertson, M.D., Toronto, Journal of the American Medical Association, April 20, 1918, p. 1134.

1. Removal of infected bits of clothing or other infected foreign matter.
2. Wide incision and drainage.
3. Immobilization.

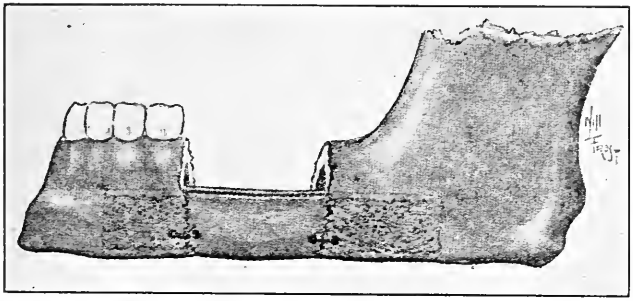

FIG. 537.—Completion of operation by the placing of the other half of the rib in contact with the first half between the ends of the fragments and by the fastening of all in place with kangaroo tendon. (After Gallie and Robertson.)

4. Continuous irrigation by the drop method with Dakin's solution of sodium hypochlorite, or continuous immersion in hot antiseptic solutions, as acetate of aluminum.
5. Stimulation of lymph drainage with Wright's solution of sodium citrate 1 part, sodium chloride 4 parts, and water 95 parts.

FIG. 538.—Soldier on whose jaw operation was performed; range of motion of jaw normal. (After Gallie and Robertson.)

6. Regular and prolonged daily exposure to the rays of the sun.
7. Continuous exposure of all wounds to the air without dressings whenever possible to avoid foreign-body reaction.

We have not made use of Clumsky's solution of camphor and phenol.

Small, superficial, slightly infected tangential wounds are rinsed with normal salt solution or hydrogen peroxide and covered with Peru balsam, or Mikulicz's salve.

Of these agents those which have proved of greatest value are:

(*a*) Solar therapy.

(*b*) Open treatment without dressings to promote drying and to prevent foreign-body reaction.

(*c*) Continuous irrigation with sodium hypochlorite solution, composed of dry sodium carbonate, chlorinated lime, boric acid, and tap water.

Naturally the method of treatment and the agents to be employed in each case are determined by the nature of the infection and the character of the wound. For our own convenience we have made the following simple classification:

GUNSHOT WOUNDS AND FRACTURES OF FACE AND JAWS.[1]

The leading features to remember are the extraordinarily rapid union of wounds in this region and the importance of not uniting the wound in the soft parts over shattered bone and pieces of impacted metal. This is especially likely to occur in the antrum and nares. The bone destruction may be terrible. In one young soldier I removed the upper jaw, half the lower jaw, the palate, part of the ethmoid, and the pterygoid plates. The soft parts were united over the huge gap, and the resulting deformity was far less than might have been expected. It is important to preserve the orbital plate of the maxilla, or, if this is impossible, to maintain intact the periosteum and suspensory ligament of the eyeball, or the latter gets displaced downward. In the "rush" of early cases I had to treat some bad fractures of the jaw without any special apparatus. I had recourse to the old molded splint of gutta-percha and jaw bandage which I had not applied for many years. All loose fragments were removed with forceps, and Mr. Acland gave his aid for the loose and injured teeth. The results in these cases were excellent and an indication of what can be done with very simple measures in very difficult cases. In fractures of the jaw extensive comminution is very frequent. I think it well to expose the parts by an incision along the inferior border and remove all the fragments of shattered bone. This is very important, or after-suppuration and obstinate sinuses are sure to persist. Pus is very apt to burrow down the neck under the cervical fascia, and I think it well to drain through the submaxillary incision. In past days I have drilled and wired the bones, but I am not sure the results were better than when simply treated by a splint. In these cases, however, the aid and skilful appliances of the dental surgeon and mechanism are very essential, and molded metal or wire splints very advantageous. In all instances the mouth should be

[1] A. Marmaduke Shield, M.B., F.R.C.S.: Injuries of War, Lancet, p. 968.

constantly washed out with an antiseptic lotion. Permanent facial paralysis is often found in wounds of the face, and is very unsightly. When the soft parts are extensively blown away the most hideous and distressing deformities ensue. What plastic surgery cannot effect must be remedied by skin-colored masks. These can often be advantageously supported on a spectacle frame (Figs. 569 and 570).

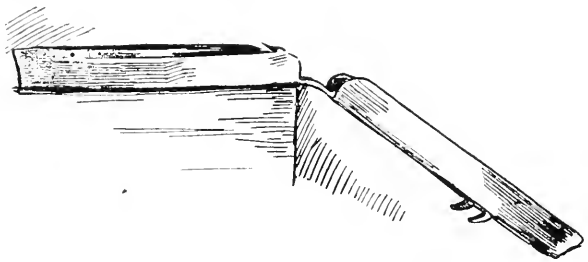

FIG. 539.—Emergency splint designed by Col. Vilray P. Blair and adopted by the U. S. Army. (Courtesy of the Detroit Dental Manufacturing Company.)

Figs. 539 and 540 illustrate an adjustable gunning or open bite splint for emergency treatment of fracture of either jaw. This splint was designed for and adopted by the United States Army. It is intended to be used for temporary treatment, to fix fractured jaws at the earliest possible moment, and to give support until the patient may be transported back to a base hospital. Before being bent for use it is a flat thin piece of metal, and therefore easily carried.

FIG. 540.—A splint bent to the required form and filled with modelling compound and ready for insertion. (Courtesy of the Detroit Dental Manufacturing Company.)

DIRECTIONS FOR USE.—*Bending.*—The pillars are to be bent down, and the splint to the form shown in Fig. 540. To do this one tray is laid on a flat surface, with the posterior ends of the tray corresponding exactly to the edge of the block and the splint bent to an angle of 137 degrees (Fig. 539). The other tray is then placed on the block and the

bending continued to 90 degrees. The bending is completed in the hand.

Adjustment.—The splint is then placed in the mouth to determine if further adjustments are needed. The arch of the trays may be compressed or expanded,-or any part of either wall bent or trimmed away.

Application.—Both trays are filled with modelling composition, made very soft either in hot water or over a flame. The splint is placed in the mouth and the teeth of the uninjured or least shattered jaw are pressed deeply into the modelling composition. The remaining fragments of the injured jaw are assembled into the best obtainable position and the teeth of this arch are also forced into the composition of the other tray. If necessary the splint may be removed and reheated. Replacing it, the composition is pressed about the crowns of the teeth. Dressings and a chin bandage, preferably elastic, are applied. A chin cup of modelling composition applied over light dressings under the bandage will add to stability. If it is desirable, the anterior ends of the two trays may be anchored together by a wire ligature.

Drainage and Repair of Soft Parts.—If possible, at the time the splint is inserted, dependent external drainage should be established at the lines of open fractures. If wounds of the cheek or lips are immediately sutured, the splint may be retained until the facial wound heals sufficiently to allow of its removal.

The following interesting cases are described by Major G. E. Meyer, D.D.S., R.A.M.C., Oral Surgeon of the Twenty-third General Hospital, British Expeditionary Force, France:

Sergeant James Brown, Regiment No. 8336, Unit 1, York Lancers, Service ten years. Single, aged twenty-seven years.

Place of Action.—Near Verlines, about 2 P.M., October 1, 1915.

Injury or Illness.—Compound fracture of lower maxilla. Mandible blown away from right lateral to about one-half inch above the angle of the jaw and the whole face, including part of the tongue. The part missing on face extended from center of chin down to lower border of neck, back to ear, and almost up to nose.

Immediate Symptoms.—Profuse hemorrhage; no pain; first aid by stretcher-bearers. Tetanus antitoxin administered at first dressing station. When patient arrived his face wound was in a horrible condition; patient running a temperature of 103°; much gangrenous tissue. Fig. 541 shows when patient entered hospital.

Treatment and Operation.—Cut away gangrenous tissue and dressed with a solution of eusol, diluted two-thirds, and irrigated. After ten days' treatment wound began to granulate in nicely. Patient had to be fed with tube. Wound irrigated every four hours with 1 to 10,000 solution of potassium permanganate.

November 1, 1915. Removed piece of necrosed bone one-half inch square. For the upper and lower teeth on the left side German silver plates were swaged, covered with silver solder and a wire soldered to

the buccal surface with several loops. On the buccal surface of the lower plate a heavy piece of German-silver plate was soldered which glided on surface of upper plate when patient closed jaw, throwing jaw

FIG. 541.—Condition when entering hospital.

FIG. 542.—After six months just after bone graft was placed.

over to left in its normal position. The first plastic operation was performed three months later. The piece of the mandible lost was replaced by a graft from the tibia. A small vulcanite splint was made to fit between swaged upper and lower plates which were laced together

FIG. 543

through loops that were made on the buccal surfaces, holding the patient's jaw open about one-half inch and immovable.

Private L. P. (Fig. 543). Aged twenty years.

Injury or Illness.—Compound fracture of the lower jaw and shrapnel wound in right arm.

Present Findings.—Lower jaw fractured between the cuspid and bicuspid. Four lower central incisors and jaw-bone between cuspids

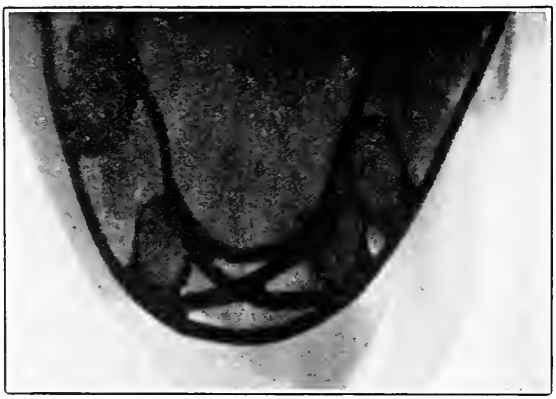

FIG. 544

completely shot away. Bullet passed down and made its exit two inches below the angle of right jaw on neck, making an opening on neck three inches in diameter.

FIG. 545.—After four months.

Doctor's Report.—The patient coughed severely and expectorated a copious mucopurulent secretion. This was never blood-tinged. It was thought at the time that the patient had an inspiration lobar

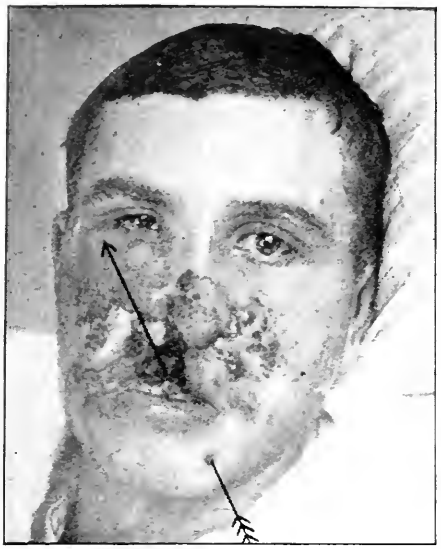

FIG. 546.—Case of Dr. C. W. Bouchet, Dr. C. J. Koenig, and Dr. W. S. Davenport. Shrapnel wound with fracture of the maxilla involving the septum of the nose and a loss of the right half of the upper lip. (Dental Cosmos.)

FIG. 547.—Same case as shown in Fig. 546, with prosthetic restoration of teeth and jaw. (Dental Cosmos.)

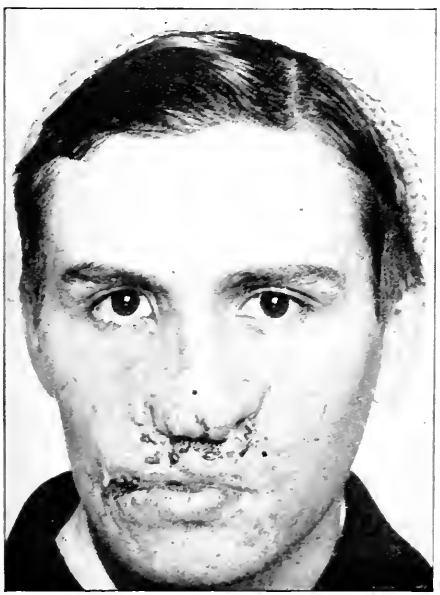

FIG. 548.—Same case as shown in Figs. 546 and 547, after plastic operation to restore lip and nose. (Dental Cosmos.)

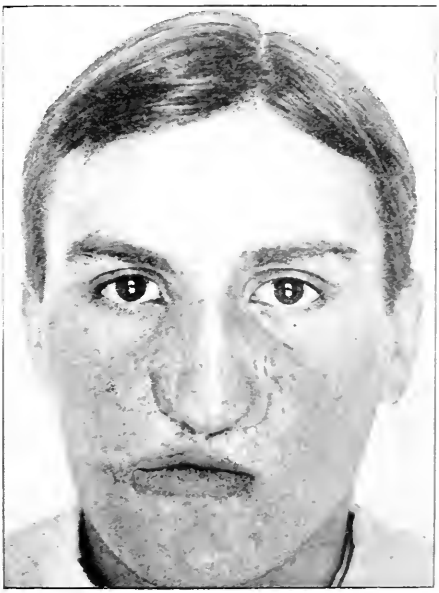

FIG. 549.—Same case as in Figs. 544, 547 and 548, showing the final result of both plastic and prosthetic restoration. (Dental Cosmos.)

pneumonia. The wound was heavily infected, but discharged. A bullet entered his open mouth and passed through the neck, carrying with it that part of the mandible between the cuspids.

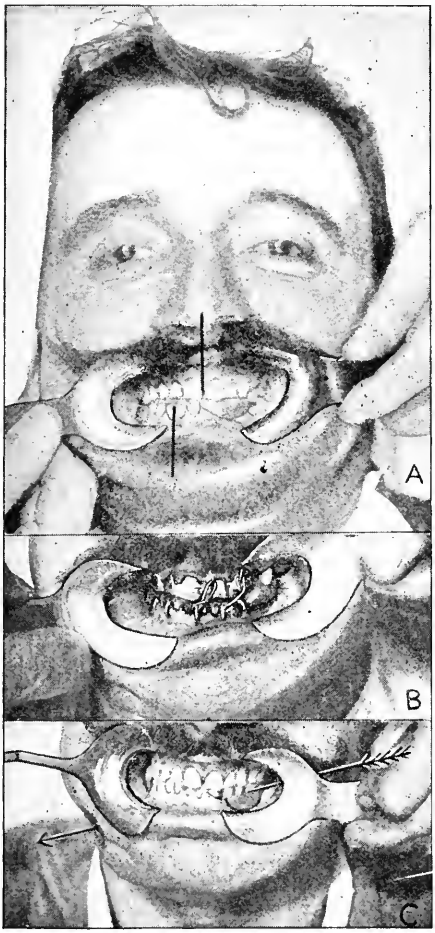

FIG. 550.—Case reported by Dr. R. B. Greenough, surgeon, and Dr. W. S. Davenport, dentist. Bullet entered the right cheek and tore away two bicuspid and the left first molar teeth and other teeth, and fractured the mandible. The splints are in place. (Dental Cosmos.)

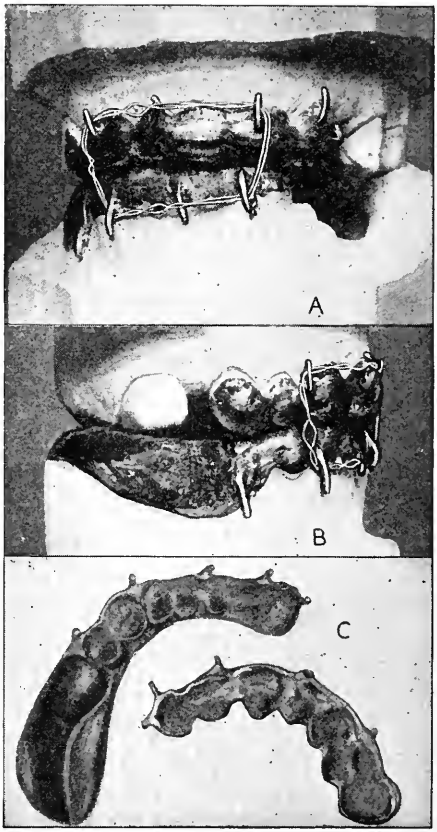

FIG. 551.—Splints used in the case shown in Fig. 550. (Dental Cosmos.)

The *x*-ray (Fig. 544) shows the splint applied to hold the two portions of the mandible in their proper position until a bone-graft could later be placed between them. Very few of the cases coming to us had sufficient teeth properly to place such a splint.

This same patient developed septic pneumonia. He entered the hospital with a temperature of 103.5° F. Generally such cases die

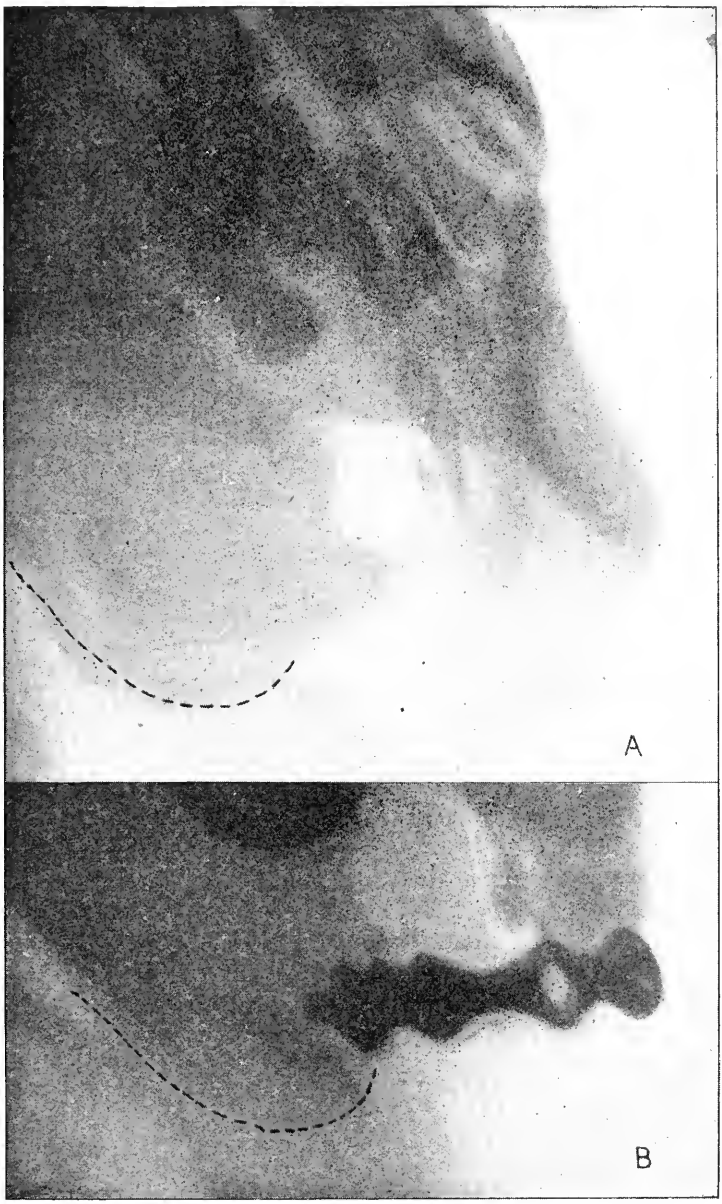

FIG. 552.—Radiographs of case shown in Figs. 550 and 551. *A* shows the fractured jaw; *B*, a Sherman four-hole metal plate fastened by two screws in the posterior fragment, to bridge the defect in the jaw-bone. (Dental Cosmos.)

before they can be brought to the base hospital. The condition of the wounded during a big offensive is terrible. At the battle of Loos

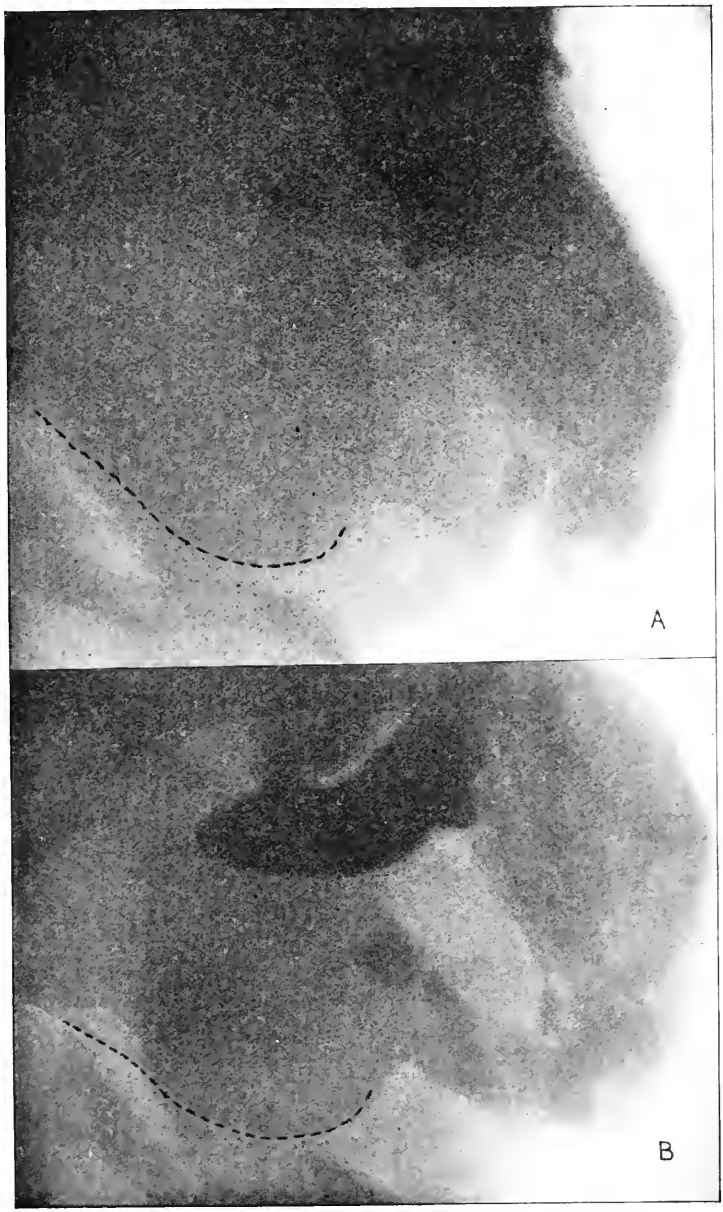

FIG. 553.—Radiographs of the same case illustrated in Figs 550, 551 and 552. *B* shows the jaw after the removal of the metal plate and the successful union of a bone graft taken by Dr. Greenough from the fifth rib slightly anterior to the sternal cartilage.

the dead could not be quickly removed from between the firing lines. At night the soldiers would crawl out, drag the bodies back to the trenches, and then throw dirt over them. Thus many dead were buried right in front of the trenches. When a shrapnel hit such a spot the horrible mess was spread in all directions. Can you wonder that shrapnel wounds are so septic?

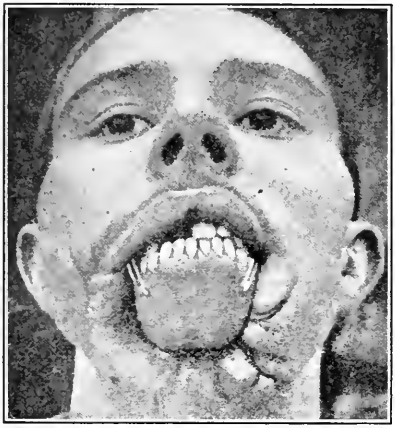

FIG. 554.—Shows a denture used in a case in which there was a total destruction of chin, lower lip and forepart of the floor of the mouth and also of the horizontal portion of the mandible from the left second molar to the right third molar. The denture was made and hinged by wires passing into the tubes and held by means of elastic bands passing from this to a wire splint fastened to the upper teeth. This served to restore the mandible so far as possible and acted also as a shield over which to mold the skin flap from the forearm. This flap was sewn to the left side of the wound on the face after its margin had been freshened. Fifteen days later the flap was separated from the arm and sutured into the wound. The red margin of the lips was reproduced by three flaps of the mucous membrane taken from the lining of the mouth. (After the War Supplement of the British Dental Journal.)

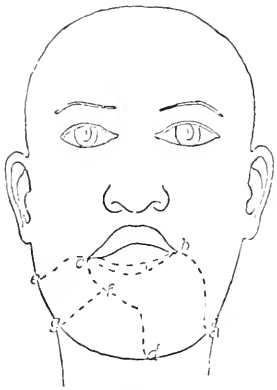

FIG. 555.—Shows in dotted outline, *a b c d*, double epithelized flap from right forearm; *d f g* and *g f c e*, flap taken from neck. The red margin of the lip taken from the mucous membrane of the mouth. (After War Supplement, British Dental Journal.)

The treatment in this case was that used successfully in many others, and was as follows: German silver pinch bands were placed on a number of the lower teeth on either side of the fracture. The ends of these pinch bands were allowed to project outward. Then the upper and lower teeth were wired together, thus bringing them to normal occlusion and reducing the fracture. Next an impression was taken of the buccal and labial surfaces of the teeth, *together with the ends of the pinch bands.* This impression was removed, the pinch

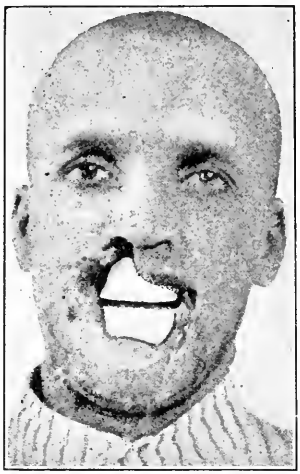

FIG. 556.—Illustrates pure tin shields in place over which plastic operations are performed as in the Düsseldorf Hospital. These shields are attached to splints and occasionally to the teeth. They support the flaps and are a guide to the depth and fulness of the lips in plastic restorations thereof. (After the War Supplement of the British Dental Journal. Cases from the hospital at Düsseldorf, by W. H. Dolamore, L.R.C.P., M.R.C.S., L.D.S.)

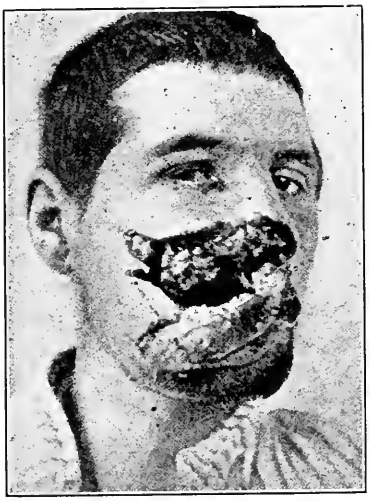

FIG. 557.—Shows injury caused by a bullet. The nasal septum, the tip of the nose, the hard palate and a considerable portion of the alveolar border was destroyed. The fractured mandible was treated with a tinned wire splint. The lip was replaced and kept in position by means of two wire hooks strapped to the forehead and supplemented with gauze.

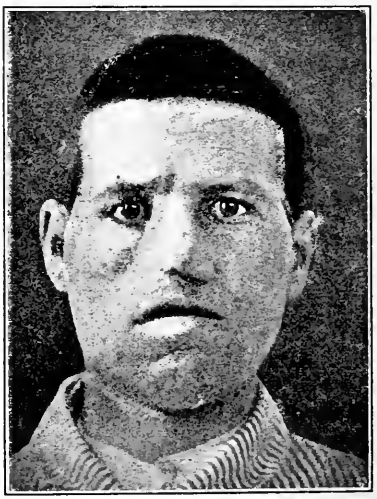

FIG. 558.—Shows the same case after wound had been surgically closed and the nasal injury corrected and illustrates the benefit of supporting portions of the lip and jaw that otherwise would hang down. (After the War Supplement of the British Dental Journal. Cases from the hospital at Düsseldorf, by W. H. Dolamore, L.R.C.P., M.R.C.S., L.D.S.)

bands were taken from the teeth and properly placed in the impression, and an investment was made with the bands in position. After cutting off the projections of the pinch bands a heavy German silver wire was

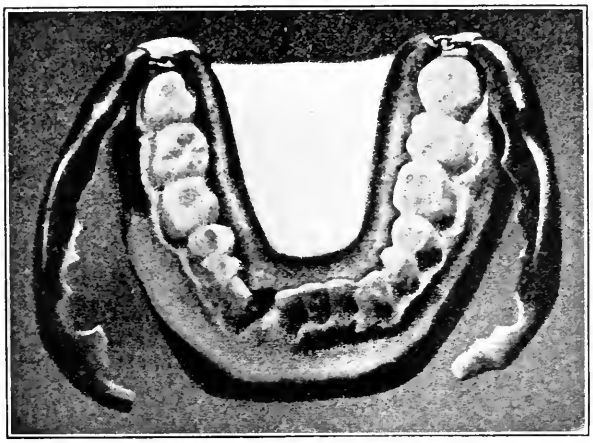

FIG. 559

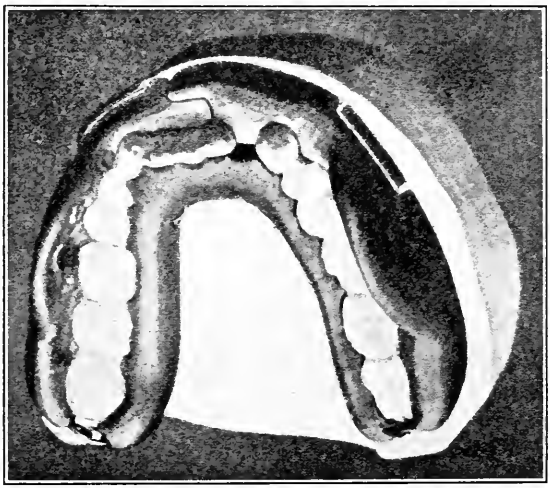

FIG. 560

FIGS. 559 and 560.—Show tin splint made in three pieces hinged posteriorly and placed in position wired to the teeth. Modelled by Hauptmeyer on a vulcanized splint designed by Kersting and described in the Deutsche med. Wochenschrift, 1904. (After the War Supplement of the British Dental Journal. Cases from the Hospital at Düsseldorf, by W. H. Dolamore, L.R.C.P., M.R.C.S., L.D.S.)

soldered to the bands on both the buccal and lingual surfaces. The wiring was then removed from the teeth, and this splint was cemented in place.

In the War Supplement of the *British Dental Journal,* Dr. A. Pont,

of Lyons, reports among the cases treated at the Lyons Stomatological center the case of oculofacial prosthesis shown in Figs. 554 and 570.

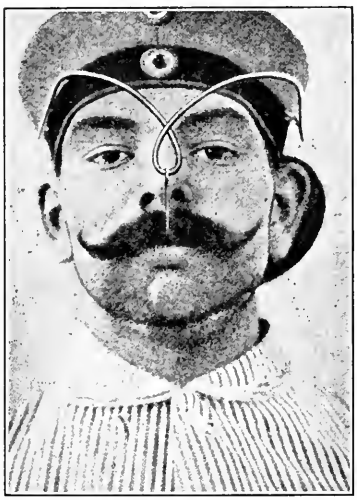

FIG. 561

FIG. 562

FIGS. 561 and 562.—Show splint made of wire attached to military cap to hold the anterior portion of the mandible where it is torn away from the posterior portions to prevent the front fragment from dropping downward with the attached muscle of the tongue and thus impeding breathing and swallowing. This splint was designed by Hauptmeyer who used it repeatedly in the field. (After War Supplement, British Dental Journal, 1916.)

FIG. 563.—Shows nasal splint designed by Ernst and sold in Germany ready made. The vertical bars end in two iron plates; these are embedded in a plaster bandage and fixed to the head. Additional support is given by two lead plates on each side at the malar bones. This apparatus is adjustable and used to support the nose and preserve the form of the nares during the healing process after injury. It consists of a double lever with a plug inserted into the nares, force exerted by elastic bands and obtained by a wire soldered to a metal cap, cemented to the upper front teeth, or if necessary, fixed to a head bandage. Various forms of this appliance have been used at the Düsseldorf Hospital. (After the War Supplement of the British Dental Journal.)

Fig. 570 may be taken as a good example of the wonderful work of this character that is now being done in the reconstruction of faces disfigured by war wounds. In the case of simple loss of the substance

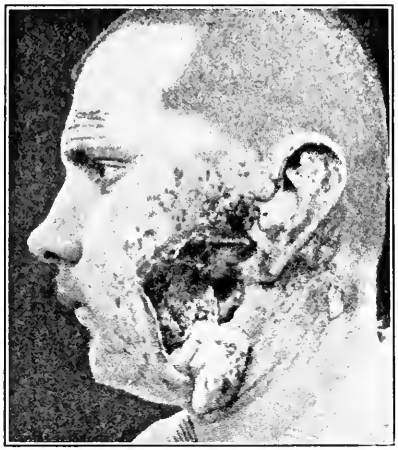

Fig. 564.—Shows the character of a wound treated according to the methods of Lindemann by plastic operations, as illustrated in Figs. 565 and 566, and treatment by exposure to the air and the sun's rays, alternately, suction glasses and washing.

of the eyeball, with preservation or efficient reconstruction of the eyelid, the prosthesis is the work of the oculist. In cases where an artificial eye cannot be placed, in consequence of the disappearance of an eyelid

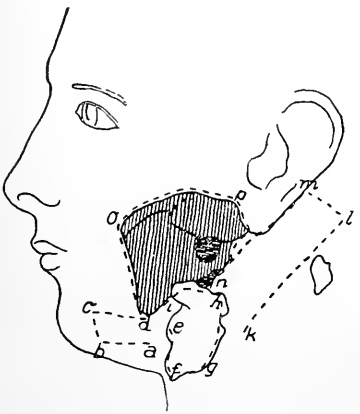

Fig. 565. — *a b c d, e f g h i, k l m n,* newly formed flaps with bases at *a d, a i, k n; d o p n,* extent of pared edges of wound.

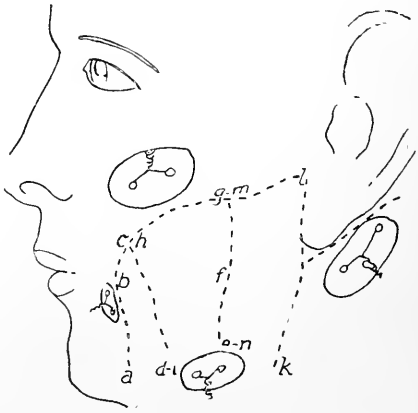

Fig. 566.—After suturing the flaps in position.

or any other cause, but when, however, there is not very much loss of peri-orbital tissue, the insertion of a replacing prosthesis such as we describe can be effected by an instrument in vulcanite or painted metal

held in place by spectacles. This is the way to proceed: One simply makes a mask of the upper part of the face; this serves as a model round which to make the artificial eye and to model the eyelid in wax;

Fig. 567

Fig. 568

Fig. 567 and 568.—Show wound closed with sutures in place. Same case illustrated in Fig. 564. (After War Supplement of the British Dental Journal.)

now one puts into the wax a piece of metal which will serve as support to the instrument and will be placed on the upper part of the rim of the spectacles.

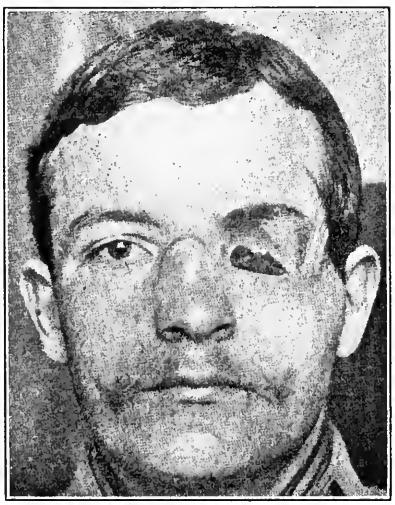

Fig. 569.—Shows loss of eye and surrounding tissue.

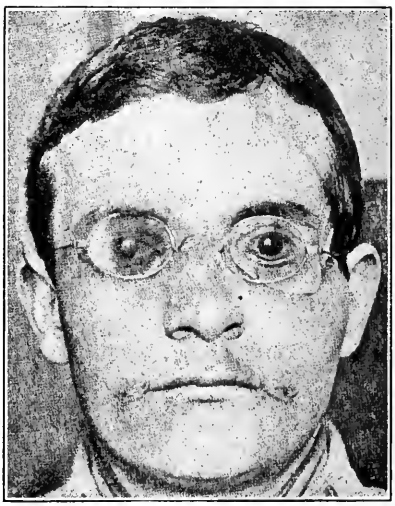

Fig. 570.—Shows the restoration of an eye attached to spectacles. (After War Supplement of the British Dental Journal.)

As soon as the wax molding is finished, one substitutes vulcanite for this wax as is done in dental prosthesis; the appliance is cast in two

parts in a bronze flask, the wax is removed from the flask by boiling in water and replacing it by rubber which is hardened by vulcanizing in a vulcanizer at the temperature of 165° for one hour.

After polishing it, the appliance can be painted, or better still, coated with hard paraffin, tinted; one thus makes over the vulcanite a true picture in wax, the surface of which represents, well enough, the dull aspect of the skin. The color being obtained, one traces on the two palpebral margins a little groove in which to place the threads, securing the artificial eyelashes, and the appliance is held in place by appropriate spectacles (Fig. 570).

MASKS OF COPPER SILVER PLATED.

The method of the English sculptor, Captain Derwent Wood, of Hospital No. 2, London, which has been used with such wonderful success by Madam Maynard Ladd, of Paris, is as follows: (1) the taking of a plaster cast of the face; (2) the making of a mask in the image of a photograph taken prior to the wounds; (3) the making of the silver-plated copper mask; (4) coloring these masks to give perfect resemblance. The result of the efforts of these great artists is said to be wonderful beyond conception in effecting the transfiguration of war-scarred and deformed faces.

SELECTED LIST OF EXAMINATION QUESTIONS.

(Be particular to know the answers to the questions indicated in *italics*.)

ANESTHESIA.

1. *Define anesthesia*, page 17
2. *Define analgesia*, page 17
3. *Define hyperesthesia*, page 236
4. *Define paresthesia*, page 236
5. *Give two principal forms of anesthesia*, page 17
6. Name the agents most commonly used for inducing general anesthesia, page 17
7. What local anesthetic agents are most frequently employed? pages 18, 19, 20
8. *How may careless use of local anesthetics in the mouth lead to serious results?* page 18
9. Describe the technic of infiltration anesthesia for the roots of the anterior teeth, pages 20–22
10. Describe the injection to block the inferior dental nerve at the lingula according to the modified Braun method, pages 23, 24
11. Give the method of conduction anesthesia for the upper jaw, page 25
12. How may the sphenopalatine injection be accomplished? pages 26–28
13. *For what purpose are local anesthetic agents sometimes used in combination with other anesthetics for surgical operation?* page 18
14. Is it advisable to give an injection of morphin and atropin before surgical operation, and why? page 34
15. Describe infiltration anesthesia, page 20
16. *What conditions should govern the choice of a general anesthetic?* pages 20, 28–32
17. What is the relative safety in administration of chloroform, ether, nitrous oxide gas and somnoform? pages 28–32, 35
18. *Describe the desirable conditions for anesthesia for mouth operations*, pages 32–35
19. *Describe the preparation of a patient for general anesthesia*, pages 35–38
20. In a general way give the relative values of the preparations most used for infiltration and conduction anesthesia, pages 20–28

HEMORRHAGE.

1. *Define hemorrhage*, page 38
2. *Name the recognized forms of hemorrhage*, pages 38, 39
3. *What are the causes of hemorrhage?* page 38
4. *Give classification of the principal forms of hemorrhage*, page 39
5. *Define epistaxis, hemoptysis, gastrorrhagia, hemorrhagic infarcts, hematoma, enterorrhagia, metrorrhagia, menorrhagia, ecchymosis*, pages 38, 39
6. *What is meant by primary hemorrhage, reactionary hemorrhage, and secondary hemorrhage?* page 39
7. *What are the local symptoms of hemorrhage?* page 39
8. *What are the general symptoms of severe hemorrhage?* page 39
9. Describe fifteen methods of arresting hemorrhage, page 39
10. *Describe the following terms as applied to the arrest of hemorrhage: ligation, forcipressure, tourniquet, Esmarch's bandage, styptics, constitutional treatment, direct transfusion of blood, intravenous infusion, proctoclysis, hypodermoclysis, heat cold, position, pressure*, page 39
11. *What preparatory treatment may be employed in preparation to avoid grave results from hemorrhage during surgical operation?* page 40
12. *Describe the treatment of grave hemorrhage and give the remedial measures in accordance with the indications of the symptoms*, pages 40, 41, 52
13. Is human blood transfusion beneficial in cases of hemophilia? pages 49–51
14. Describe a method of indirect transfusion and give the dangers to be avoided in the procedure, pages 43–47

SHOCK.

1. *Define shock*, page 52
2. Enumerate some of the psychic and operative causes of shock in surgical conditions, pages 52, 53
3. Name some of the predisposing and also important direct factors in shock, page 53
4. *Describe the symptoms of shock in a graduated way from simple to grave conditions*, page 55
5. *Describe coma*, page 55
6. *What prophylactic treatment may be given in anticipation of shock to reduce its severity?* pages 55, 56
7. *Give postoperative treatment of surgical cases with reference to shock*, pages 56–58

PATHOLOGICAL DENTITION.

1. Name and classify the principal causes of pathological dentition, page 59
2. *Give the local and general symptoms of difficult dentition in infants and adults*, pages 60, 61
3. *How may serious general symptoms occur in infant cases during tooth eruptions?* page 59
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